Biosocial determinants of healthy ageing in Spain

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PhD Thesis

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Abstract

This dissertation explores biological (physical) and social characteristics associated with health later in life, integrating gender/sex considerations and a life course perspective. We use data from 50-years-old and older Spanish and other European adults from two different sources: the Active Ageing Longitudinal Study "Estudio Longitudinal de Envejecimiento Activo" (ELEA) in Spain, and the Survey of Health, Ageing and Retirement in Europe (SHARE). This study includes cross-sectional and longitudinal (both prospective and retrospective) designs and embraces a broad set of variables such as demographic characteristics, socioeconomic and health indicators, early health and socioeconomic conditions, etc.

Results are presented in five original papers. Cross-sectionally, we found that, compared to men, part of the overall poorer health among women was surely determined by a gender effect and may have had an early origin, probably related to traditional gender roles established early in life. Additionally, we found marked socioeconomic gradients in health and mobility indicators like frailty and balance performance. Health behaviours like physical activity and obesity seemed to play a similar and small role in explaining the link between socioeconomic status and frailty and balance in older adults. Longitudinally, in a prospective study of the predictors of disability for two years, we found that a decline in function was associated with an increased number of chronic diseases and symptoms of depression among Spanish men, whereas among women it was associated with decreased cognitive performance. Finally, in a retrospective study with a life course approach, we found a direct association between childhood and adult health among older Europeans, whereas the impact of the socioeconomic status in childhood was more indirect and operated through the own socioeconomic status in adulthood. This suggests that in order to improve adult health, efforts can be made in ameliorating child health. Moreover, poor childhood health was a stronger predictor of adult health -having more negative effect- in Northern compared to other European countries. This finding may be useful for planning interventions based on country-specific evidence, and contributes to the understanding of the mechanisms underneath the health dynamics over the life course.

The results of this study add to the evidence of the importance of including a multidisciplinary and life course perspective when evaluating health and well-being in later life. They might also contribute to enhance health and reduce health inequalities by suggesting effective interventions meant to improve the quality of life of older adults.

Key words: Healthy ageing; adult health; biosocial determinants; gender; life course; social inequalities; ELEA; SHARE; Spain; Europe.

Abstract (Spanish)

Esta tesis explora características biológicas y sociales asociadas a la salud en la edad adulta, integrando consideraciones de género-biología y una perspectiva de ciclo vital. Se utilizan datos de individuos españoles y europeos mayores de 50 años de edad provenientes de dos fuentes: el Estudio Longitudinal de Envejecimiento Activo (ELEA) en España y la Encuesta de Salud, Envejecimiento y Jubilación de Europa (Survey of Health, Ageing and Retirement in Europe; SHARE). Este estudio incluye diseños transversales y longitudinales (prospectivos y retrospectivos), abarcando un amplio grupo de variables tales como aspectos demográficos, indicadores socioeconómicos y de salud, salud y condiciones socioeconómicas tempranas, etc.

Los resultados se estructuran en cinco artículos originales. Los estudios transversales mostraron que parte de la peor salud general de las mujeres en relación a los hombres estaría determinada por un efecto de género y podría tener un origen temprano, relacionado probablemente a los roles tradicionales de género establecidos a temprana edad y condicionado mayormente por el acceso a la educación. Además, encontramos marcados gradientes socioeconómicos en distintos indicadores de salud y mobilidad como fragilidad y equilibrio. Aunque asociados a peores indicadores de salud, malos comportamientos de salud como la inactividad física o la obesidad parecen jugar un papel similar con una contribución relativamente menor en explicar las desigualdades en fragilidad y equilibrio en los adultos mayores españoles. Por otra parte, estudiando los predictores de discapacidad a lo largo de dos años en el estudio longitudinal prospectivo, observamos que una pérdida en funcionalidad física estaba asociada a un aumento de enfermedades y síntomas depresivos entre los hombres españoles, mientras que en las mujeres se asociaba a una disminución del funcionamiento cognitivo. Finalmente, en el estudio retrospectivo con un enfoque de ciclo vital, encontramos una asociación directa entre la salud temprana y adulta en adultos

europeos, mientras que el impacto del nivel socioeconómico en la niñez era más indirecto, operando mediante el propio nivel socioeconómico en la edad adulta. Esto sugiere que para mejorar la salud en etapas posteriores del ciclo vital, parte de los esfuerzos deberían destinarse a mejorar la salud temprana. Además, una pobre salud en la niñez resultó un mayor predictor de salud (teniendo un efecto más negativo) en los países del norte comparados con otros países europeos. Este resultado puede ser útil para desarrollar intervenciones basadas en evidencias particulares y contribuye al conocimiento de los mecanismos subyacentes a las dinámicas de salud a lo largo del ciclo vital.

Los resultados de este estudio añaden a la evidencia existente acerca de la importancia de incluir una perspectiva multidisciplinar y de ciclo vital a la hora de estudiar la salud y bienestar en la edad adulta. También puede contribuir a mejorar la salud y disminuir las diferencias en la misma, sugiriendo intervenciones efectivas dirigidas a mejorar la calidad de vida de los adultos mayores.

Palabras clave: Envejecimiento saludable; salud adulta; determinantes biosociales; género; ciclo vital; desigualdades sociales; ELEA; SHARE; España; Europa.

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Madrid, February 2014.

Santiago Rodríguez López

List of original publications

The study is based on the following original publications:

I Montero López P, Fernández-Ballesteros R, Marrodán Zamarrón MD, Rodríguez López S. (2011). Anthropometric, body composition and health determinants of active ageing: A gender approach. *Journal of Biosocial Science*, 43:597-610.

II Rodríguez López S, Nilsson C, Lund R, Montero López P, Fernández-Ballesteros R, Avlund K. (2012). Social inequality in dynamic balance performance in an early old age Spanish population: The role of health and lifestyle associated factors. *Archives of Gerontology and Geriatrics*, 54:e139-e145

III Rodríguez López S, Montero López P, Carmenate Moreno M. Educational inequalities and frailty in Spain: What is the role of obesity?. Accepted for publication: *The Journal of Frailty & Aging* (January 2014)

IV Rodríguez López S, Montero López P, Carmenate Moreno M, Avendano M. (2013). Functional decline over 2 years in older Spanish adults: Evidence from the Survey of Health, Ageing and Retirement in Europe. *Geriatrics & Gerontology International*, doi:10.1111/ggi.12115.

V Rodríguez López S, Myrskylä M, González Montoro AM, Montero López P. The long-term health implications of poor childhood health: Evidence of regional variation from the Survey of Health, Ageing and Retirement in Europe. Submitted for publication: *Population Studies* (February 2014)

Abbreviations

95% CI	95% Confidence Intervals
AA	Active Ageing
AIC	Akaike Information Criterion
ADL	Activities of Daily Living
ANOVA	Analysis of Variance
ATPIII	Adult Treatment Panel III
BIC	Bayesian Information Criterion
BMI	Body Mass Index (kg/m^2)
CEMFI	Centro de Estudios Monetarios y Financieros (Spain)
ELEA	Estudio Longitudinal de Envejecimiento Activo
ELSA	English Longitudinal Study of Ageing
EURO-D	European Depression Scale
FD	Functional Decline
HA	Healthy Ageing
HRS	Health and Retirement Study
IADL	Instrumental Activities of Daily Living
IECM	Instituto de Estadística de la Comunidad de Madrid (Spain)
INE	Instituto Nacional de Estadística (Spain)
ISCED	International Standard Classification of Education
LE	Life Expectancy
MMSE	Mini Mental State Examination
OR	Odds Ratio
PUMA	Programa Universitario de Mayores
SD	Standard Deviation
SES	Socioeconomic Status
SHARE	Survey of Health, Ageing and Retirement in Europe
SHARELIFE	Wave 3 of SHARE

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SRHS	Self-Reported Health Status
W(1-4)	Waves(1-4) of SHARE
WHO	World Health Organization

Contents

Introduction

1.1 Population ageing and the *health paradox* in Spain

Population ageing is a major challenge for all countries in Europe. The age structure of the population has changed over recent decades and there has been an unprecedented increase in the number of older people. According to the European Union Prospective “Confronting demographic changes, solidarity between generations”(2008), the population over 75 years will increase from 26.4 million in 2000 to 45.3 in 2030 due to ageing population, who starred the baby boom of the 70’s and the enhance in life expectancy (LE) beyond the seventy-five years. In Spain in 2006, more than 7 million people were over 65 years and 1,300,000 over 80. In our country, between 1980 and 2005, male LE at birth has increased from 72.5 to 77.0 years and female from 78.6 to 83.5 years [1], while the LE free of disability is around 7 years for the total population. Hence, an important question is whether the above mentioned increases in LE will increases LE free of disability (the “increase”scenario) or if on the contrary, new policies intending to promote healthy ageing and prevent disability will have a positive impact in reducing it (hypothesis of “reduction of morbidity”) [2, 3].

Spain is one of the European countries where high LE and low mortality rates coexist with a very high level of functional disability. This health issue is relevant within the described context and evaluating the determinants of this disability may contribute to explore answers to this paradox.

1.2 Studying healthy ageing: Active Ageing and its bio/psycho/social frame

There is an individual variability in the ageing process that causes important physiological differences among individuals with the same chronological age [2, 4]. Owing to this discrepancy between chronological and biological or physiological age, it is difficult to define what normal ageing is. The widely accepted notion of successful ageing was established by Rowe & Kahn in 1997 [5]. They proposed a multidimensional concept called Active Ageing (AA), defined by several biological, psychological and social factors, which is based on the lack of illnesses or disability, good physical and cognitive functioning, and active social participation. They classified the many ways of ageing into three categories: common, pathological and successful ageing, although other terms are similarly used to describe successful ageing, such as healthy ageing [6], apt ageing [2, 7], active ageing [8, 9] and productive ageing [10].

In our study we use the concept of AA to represent the terms referring to successful ageing. AA is a scientific concept that requires a multidisciplinary research and most authors agree on the fact that the determinants of AA must be studied from a bio-psycho-social perspective. The collaboration between professionals from different areas is important to achieve an effective promotion of AA which takes into account the biological, psychological and sociocultural determinants involved in this complex process.

AA is associated with different factors in men and women. Some studies have shown that, among women, AA is negatively related to physical and physiological variables associated with poor health, whereas in men it seems that social factors such as educational level and occupation may have more influence. Other studies have shown great differences in the prevalence of AA among older adults, depending on the domains considered to define it [11, 12]. More recently, McLaughlin et al. [13] estimated the prevalence of healthy aged North-Americans in 12%. In Europe, a comparative cross-sectional study following Rowe and Kahn's criteria have shown prevalences of AA ranging from 21.1% in Denmark to 1.6% in Poland [14]. In the case of Spain this prevalence is 3.1%, one of the lowest among all the European countries. However, this approach has also been criticised. It was suggested that the comparison of the prevalences of active agers across studies is of limited use given the wide variety of definitions and measurement approaches [12].

These cross-national differences are partially due to the environmental, economic, cultural and social conditions in a particular historical context that affect the ageing process. Historical disparities among these characteristics between men and women are more accentuated in older ages. Thus, the current objective of health initiatives to increase LE free of disability in the next years can only be achieved by fully incorporating a gender perspective in population studies and by considering different measures for men and women.

1.3 Gender/sex integrated aspects in health and welfare research

The main factors behind the demographic changes mentioned above are related to economic and social development: declining fertility rates and increasing LE are related to improvements in living conditions of the population and medical care that have affected women and men differently [8]. The control of mortality associated to childbirth and puerperium has been one of the factors that has increased LE in women, but there are other factors responsible for inequalities that would be accountable for the observed differences in the life quality of older men and women. Although women have about 7 years longer LE than men, their LE free of disability is lower [15]. Therefore, the gender perspective is essential when analysing health of the older European population.

In general, both objective and perceived health get worse throughout life and the gender-based approach is of special interest in this sense, since women have poorer health than men. The World Health Organization (WHO) states that the gender position during the ageing process is a factor that conditions adult health [8]. Particularly in Spain, four out of ten women over 65 classified their health as poor or very poor, whereas this occurred in three out of ten men [1]. Although women live longer than men, only 65% of them reported living in good health, compared to the 70% declared by men. The different perception related to health might be due to gender inequality in employment and economic, personal and leisure autonomy. Mortality and morbidity rates and the trends of specific diseases among older people also differ from men and women. Most of these differences might be rooted in the development conditions in early and later life, since throughout their life course, men and women are exposed to different risk factors that influence their health in later years [16].

Most of the participants in the present study were born between 1935 and 1950. At that time, Spain was one of the poorest countries in Europe. There have been changes in the political system (1930-36), the occurrence of the Civil War (1936-39) and the postwar period (1939-50), coinciding with the Second

World War, which led to the isolation of Spain, food shortages and other negative events, with the corresponding increase of mortality and morbidity. Older people from this generation might be considered "survivors" and their bio-physical and psychological characteristics need to be considered within this historical context. This highlights the necessity of having a deep knowledge of the interaction between gender, health and ageing.

The biological ageing process is characterised by a progressive decrease in functional capacity in all tissues and organs of the body, and by the decreased ability to respond and adjust to environmental changes [4]. At the individual level, ageing is a process that has no precise beginning, it occurs throughout the life and depends on genetic, biological and psychological factors [2, 5, 17]. The physiological changes that occur throughout the ageing process involve a remodelling in the size, shape and body composition [18]. These variations in body size are mainly due to a loss of height -due to compression of the intervertebral discs, to the loss of bone mass and the loss of plantar arch curvature [19].

Body composition is affected by a decrease in metabolically active lean body mass, due to loss of muscle mass (sarcopenia) [20] and of cells from different tissues and organs, as well as from the skeleton demineralisation [21]. The reduction of lean mass in skeletal muscle results in a loss of strength and greater fatigue which can lead to the abandonment of simple activities and to the increased risk of falls. These changes in body composition are associated with functional decline (FD), disability and morbidity [22]. Not only would these factors have a negative influence on life quality by increasing the degree of dependence, but also they would enhance the risk of mortality and morbidity [23].

The changes in body composition associated with ageing have different consequences in men and women. Differences in body composition between men and women exist since puberty. There is a higher prevalence of fat mass in women than in men -25% vs. 15%- and greater muscle and bone mass in men. Women have higher calcium requirements associated with pregnancy and lactation and the differences in calcium metabolism mediated by oestrogens produce a rapid loss of bone mass in the years following menopause. The loss of bone mass in women is higher than in men and may lead to osteoporosis problems and fractures more frequently than in men. Among women, it is very common to experience obesity and sarcopenia simultaneously. Moreover, body fat distribution -different between men and women- is also a determinant of cardiovascular risk. All these factors are influenced by the environmental conditions throughout the life course: primarily nutrition and energy expenditure associated with daily physical activity heavily depend on the gender position, especially among population groups whose living conditions were unfavourable in the early years of their life.

The use of the Body Mass Index (BMI) -considered as a good indicator of underweight, overweight and obesity- is controversial among older individuals. This is mainly due to difficulties in obtaining accurate height values and also because BMI does not take into account neither the total amount of fat nor its distribution [24]. However, other measures such as span -the distance from the breastbone to the tip of the middle finger, the arm circumference and subcutaneous fat skinfolds can be used to obtain more accurate information. In addition, many studies have shown an association between higher values of BMI with lower mortality risk in men and women over 70 years, but abdominal obesity is particularly associated with an increased risk of cardiovascular disease. In this study we use BMI from both measured and self-reports of weight and height, despite the large debate on whether this last is a reliable indicator of the nutritional status. In this line, many studies have found a general overestimation of height and an underestimation of weight, resulting in an underestimation of BMI [25, 26].

1.4 The life course perspective when studying health in adulthood

Inequalities between older men and women continue to increase with age. These inequalities can only be explained from a life course perspective and as a result of the interaction between biological and social factors over the life course. Particularly, it was suggested that the study of adult health cannot be fully accomplished without considering the exposure to the different environmental conditions throughout the life course [27].

In the last years there has been renew interest for explaining causality patterns between both childhood socioeconomic (SE) and health conditions and their consequences in adult life -in health, SE achievement, etc. [28–32]. Consequently, many studies have focused on the association between life course SE conditions with different health outcomes in adulthood [33–38]. One of the main arguments of those studies is that the social environment during the growth period is strongly associated with the health conditions accumulated over the life course and therefore, affect health in adulthood [39].

Although adult SE conditions remain the most commonly addressed aspects of health disparities [32], large evidence suggests that conditions early in life have long-term effects on health at older ages [40]. Thus, childhood health, nutritional status, socioeconomic status (SES), place of residence and other household characteristics also contribute to disparities in adult health [27, 35].

There is evidence on two major and sometimes conflicting models to explain how early life environment influences health in later life [41]. Among the mechanisms through which childhood environment influences adult health, there is the *direct* effect of childhood into adult health [42]. This can be described as a *latency model*, which emphasises the strong independent effects on health status late in life, of discrete events that tend to occur early in life [41]. The associations between birthweight, placenta size and weight gain in the first year of life with cardiovascular disease in the fifth decade have been described [43]. It is hypothesised that, in the case of the latter associations, future adult disease is "programmed" during foetal life and infancy.

On the other hand, there are other *indirect* mechanisms operating through attained adult characteristics (e.g., SES and lifestyle factors) [44]. This can be described as a *pathways model*, which emphasises the role of early environment on subsequent life trajectories, which in turn influence adult health. In other words the pathways model focuses on the cumulative effect of life events along developmental trajectories, and it thereby implicates conditions of life throughout the life course in adult disease causation [41, 45]. Figure 1.1 shows the potential mechanisms linking childhood and adult health described above that are addressed in this study.

The importance of distinguishing between these two mechanisms relies on contributing to the study of health trajectories over the life course, leading to suggest efficient interventions to improve adult health.

The existing evidence about childhood conditions as good predictors of adult health, together with the differential exposure to health risk factors along the life course in men and women [46], may suggest that gender differences in later life health have an early origin. Thus, in order to improve later life health, it is important to detect the early determinants of adult health and to identify how health trajectories are represented in both men and women from different environments.

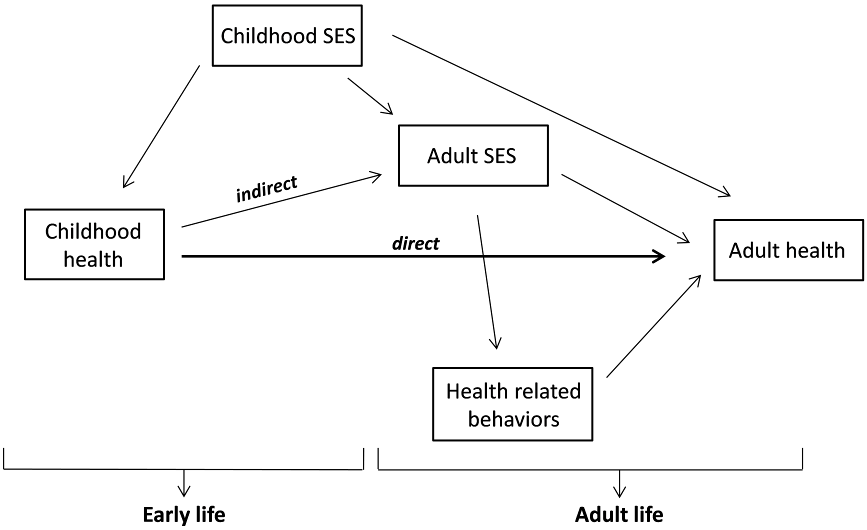

Figure 1.1: Potential mechanisms linking childhood and adult health.

1.5 New contributions to the study of the determinants of health and well-being in older adults

There is a persistent interest in researching the determinants of health in older adults, being specially important in the Spanish population due to the context mentioned above. The present study is structured based on five original papers which intend to summarise the relevance of undertaking the study of adult health from a multidisciplinary and life course perspective, by considering biological and social integrated aspects.

In Paper I (4.1) we evaluate, from a gender approach, how different physical and social characteristics are associated with AA among Spanish adults. It is known that men and women are exposed to different risk factors along the life course that affect their health in later years [47] and that this differential exposure is often due to different gender roles established early in life [16]. In this study we use a combined indicator of health like AA, which has been proposed to embrace the bio-psycho-social dimension of healthy ageing [8]. Moreover, the United Nations Research Agenda on Ageing for the 21st Century stated the need for research into the determinants of this type of positive ageing as a priority [48]. Both Papers I (4.1) and II (4.2) are based on cross-sectional data from the Active Ageing Longitudinal Study "Estudio Longitudinal de Envejecimiento Activo"(ELEA) -developed by the Psychobiology Group of the Universidad Autónoma de Madrid (See Table 2.1).

Papers II (4.2) and III (4.3) provide somehow similar cross-sectional evidences on the role of different health behaviours in explaining health inequalities in adulthood. It has been previously described how social inequalities in health are distributed in the Spanish population [49]. However, the role that health-related behaviours might play in such association is less known. Paper II (4.2) focuses on educational and income inequalities in an objective measure of mobility like dynamic balance, and how objective obesity and physical activity are associated. Balance performance is considered a good indicator of adult health and one of the most important determinants to protect independence later in life [50], while poor balance performance is an important cause of loss of independent mobility [51]. This paper was elaborated during a research visit to the Department of Public Health, Section of Social Medicine, University of Copenhagen, Denmark, and supervised by Prof. Kirsten Avlund†.

Papers III (4.3) and IV (4.4) use data of the Spanish sample from the Survey of Health, Ageing and Retirement in Europe (SHARE). First, Paper III (4.3) investigates educational differences in the prevalence of frailty phenotypes -an indicator of health status in old age and a good predictor of disability in adulthood [52]- and the specific role of obesity in such association. Previous research examined the association between SES and frailty [53–55], while others investigating the relationship between obesity and frailty have been comparatively minor [56, 57]. Few studies have examined, however, how obesity is related to frailty within different educational backgrounds. The importance of determining the role of obesity in the development of frailty has been recently suggested [58], since probably the most common phenotype of frailty in the near future will be characterised by the concurrent and interacting presence of obesity [59]. In a recent study, Macklai et al. [60] found that a SHARE's frailty phenotype [52] is significantly associated with large health outcomes, independent of baseline morbidity and disability in community-dwelling European men and women aged 60 and older. The robustness of these results and others [61] validate the use of this phenotype in SHARE for future research on frailty in Europe.

Paper IV (4.4) introduces the longitudinal perspective in our study using SHARE's data. We include a longitudinal analysis of disability and FD in the

Spanish population, by evaluating social, educational, health and behavioural predictors of physical FD. Earlier research have examined associations between health and disability measures [62], but few studies have examined how broader social, educational and behavioural determinants are related to FD in Spain. Here we provide a comprehensive examination of the predictors of changes in FD in older Spanish adults based on longitudinal data. Our study is innovative by examining how both baseline and 2-year changes in predictors relate to changes in FD, and by assessing a wide array of potential predictors across multiple domains.

Finally, Paper V (4.5) is based on SHARE's international panel data, including ten European countries. We evaluate how poor health in childhood is associated with individuals' later life health within different European regions, assessing whether both the exposure to different SE situations over the life course and health risk behaviours in adulthood mediated such association, over a 6.6-year window. A growing body of evidence in the last years suggests that conditions early in life have long-term effects on health at older ages [63–65]. However, most of the studies on the multiple determinants of health across the life course do not include cross-national/regional comparisons and, to our knowledge, our study provides the first regional-specific evidence of historical differences in the childhood-adult health association. This paper was elaborated during a research visit to the Max Planck Institute for Demographic Research, Research Group Life Course Dynamics and Demographic Change, Rostock, Germany, and supervised by Prof. Mikko Myrskylä.

Objectives

The determinants of health in older adults should be studied from a multidisciplinary and life course perspective. Our research hypothesis is that the gender/biology interaction remains all along the life course and distinctively conditions later life health in men and women. This study aims to evaluate how biological and social factors are associated with health later in life, incorporating a gender approach into the study of health in adulthood, allowing for the integration of health and environment research considerations throughout the life course. Within this context, the specific objectives of this study are:

1. Evaluate how biological (physical) and socioeconomic (educational attainment, income, profession, etc.) determinants of health are associated with active ageing in Spanish men and women.

2. Assess SE disparities in adult health indicators such as frailty and balance in Spain, estimating the contribution of modifiable health behaviours on such inequalities.

3. Estimate SE, health and behavioural predictors of physical functional decline among Spanish adults.

4. Evaluate, from a life course perspective, the importance of childhood conditions in determining later life health among older European adults.

Material and Methods

2.1 Study design and participants

Data from two different sources were used in this study: the Active Ageing Longitudinal Study “Estudio Longitudinal de Envejecimiento Activo”(ELEA) and the Survey of Health, Ageing and Retirement in Europe (SHARE). Both samples are complementary, and provide different perspectives to this study. The use of two data sets independently, enhances the scope of the analyses by allowing the use of complementary variables and by performing cross-sectional, longitudinal and retrospective analysis. Table 2.1 resumes the data used in every paper.

2.1.1 Active Ageing Longitudinal Study: the ELEA project

The ELEA was developed by the Psychobiology Group of the Universidad Autónoma de Madrid in 2006. It has a longitudinal design, although at the moment of the present study only the baseline sample was available. Baseline sample is formed by 456 -65 to 80 years- men and women from rural and urban areas of the Comunidad Autónoma of Madrid (Madrid and Toledo), Spain. It also includes a sub sample from the PUMA (n=24). Participants were interviewed and measured in homes and in older adults community institutions.

One strength of the ELEA is that it includes many anthropometric indicators, physical performance tests and other objectively measured health variables. On the other hand, the cross-sectional outline somehow restricts the scope of our study. Overall, it represents a good source of data which is used in Papers I (4.1) and II (4.2) of this study. See those papers for more details on the methodology and data collection.

2.1.2 The Survey of Health, Ageing and Retirement in Europe (SHARE)

SHARE is a multidisciplinary and cross-national panel database of micro data on health, SES and social and family networks of more than 85,000 individuals from 19 European countries. It includes population-based data on economic, social, and health conditions for Spanish and other European individuals. Based on probability samples in all participating countries, SHARE represents the non-institutionalised population aged 50 and older. The survey has been designed and harmonised following the Health and Retirement Study (HRS) of North America and the English Longitudinal Study of Ageing (ELSA). The Centre of Monetary and Financial Studies (Centro de Estudios Monetarios y Financieros (CEMFI)) is the SHARE's responsible institution in Spain (www.share.cemfi.es).

At the moment of the present study SHARE has released four waves. Baseline sample (W1) was recruited in 2004/05, while further waves such as the second (W2), third (W3, SHARELIFE), and fourth (W4) were released in 2006/07, 2008/09 and 2011/12, respectively. With the inclusion of W2 and further waves, SHARE went into its longitudinal dimension, allowing for different approaches.

SHARELIFE includes retrospective data on early SE and health indicators, to elucidate how early life experiences and events throughout life influence the circumstances of older people. SHARELIFE included a Life History Calendar, designed to help respondents in remembering past events more accurately. The use of the life history calendar technique has been shown to improve the accuracy of the retrospective information given by respondents [66]. See www.share-project.org for more specific information on the methodology.

In our study we use baseline (W1) (Paper III (4.3)) and longitudinal (W1-W2) (Paper IV (4.4)) data for Spain. Moreover, we include longitudinal (W1-W3-W4) data for ten European countries (Paper V (4.5)), including Denmark, Sweden, Germany, Switzerland, The Netherlands, Austria, France, Belgium, Italy and Spain (see Table 2.1 for more details on this).

2.2 Outcomes

Most of the outcomes considered in this study are a combination of several variables (e.g. *Active Ageing*, *Dynamic Balance*, *Frailty phenotype*, and *Functional Decline*). The decision on focusing on these types of indicators relies on the differences between the samples considered in each paper. Compared to when evaluating a specific health outcome, the use of combined outcomes gives a somehow broader perspective of the health status in each particular analysis. Contrarily, in many cases these outcomes do not provide for specific information and restricts the contrast and comparison of the findings by limiting the chances of its replication. Despite this limitation, we consider that the use of combined indicators provides a broader notion of the general health status of the studied population.

2.3 Statistical analysis

A somehow similar methodology was followed in every paper. First, some descriptive statistics and bi-variant associative analysis -χ^2, t-test, ANOVA, etc.- were performed, followed by different predictive models. We used linear, negative binomial, logistic, or multinomial logistic regression analysis depending on the studied outcome. Non-parametric analysis were used when appropriated.

Since odd ratios (ORs) values are sometimes difficult to interpret when effects are protective, in most studies we present them as non-protective [67] (ORs>1.00). So, the lowest risk category in every case is selected as the joint/reference category, resulting in a positive difference for higher risk categories.

In addition, SHARE includes different sets and types of weights, which can be used depending on the concrete research question [68]. Particularly, in this study we have used calibrated longitudinal weights in Paper IV (4.4). These weights are only defined for the longitudinal sample and compensate for problems of attrition between two or more waves. Thus, they are calibrated to match, e.g., the target population of W1 that survives in W2, so they also account for mortality, which is a phenomenon affecting both the sample and the population [69].

Statistical analysis were performed using Stata Statistical Software [70], the Statistical Package for Social Sciences [71] and R [72].

Table 2.1: Study designs, populations and outcomes

Study	**Dataset**	**Design**	**Participants**	**Age (mean±SD)**	**Primary outcomes**
I	ELEA	Cross-sectional	Spain 456	54-75 (66.5±5.4)	Active Ageing
II	ELEA	Cross-sectional	Spain 448	54-75 (66.4±5.3)	Dynamic Balance
III	SHARE	Cross-sectional	Spain 2,319	50-103 (66.8±10.6)	Frailty Phenotype
IV	SHARE	Longitudinal 2-year follow-up	Spain 699	65-103 (74.3±6.4)	Functional Decline
V	SHARE	Longitudinal 6.6-year follow-up Retrospective	Ten countries 7,118	65-103 (63.4±8.8)	Self-reported health Chronic conditions Grip strength

Results and Discussion

3.1 Summary of the results

This section provides a brief summary of the main findings from the original papers. The first results describe the factors associated to AA in Spanish men and women (Paper I (4.1)). Then, we summarise the role of different health behaviours on educational and income inequalities in health indicators such as dynamic balance and frailty (Papers II (4.2) and III (4.3), respectively). Then, we address the predictors of physical FD in Spain in a longitudinal analysis (Paper IV (4.4)). Finally, we present longitudinal evidences on the childhood-adult health association and the regional differences observed across Europe (Paper V (4.5)).

3.1.1 Gender differences in active ageing in Spain (Paper I)

In Paper I (4.1) we analyse, from a gender perspective, how physical, health and SE factors are associated with AA in Spain. Our sample is formed by 456 community-dwelling Spanish adults (169 men and 287 women), mean age 66.5 years old (range 54-75 years).

To describe the factors associated with AA, we created a dichotomous variable "active ageing" (AA) (yes/no), based on the main dimensions of AA reported by Depp and Jeste [12]: cognitive and disability/illness/physical functioning, subjective health, satisfaction with life and productive activity performed.

We found AA to be associated with anthropometric variables, physical health indicators and socio-demographic characteristics. Men have better general health than women. The prevalence of active agers is higher in men than in women

(38.4% vs. 21.9%; p<0.001), and compared to women, men have lower prevalence of obesity (29.0% vs. 37.6%; p<0.01), significantly lower metabolic risk (42.9% vs. 60.6%; p<0.001) and better self-perceived health (19.5% of men reported very good health vs. 11.8% of women; p<0.005).

Table 3.2 shows the main results based on multiple logistic regression analysis. Being women and the number of diagnosed diseases are factors that risk AA. On the other hand, the years of education are a protective factor for AA. The results for the total sample highlights the importance of the absence of diseases and high educational background in achieving AA. However, educational background is significantly associated with AA in men, while in women remains marginally related.

Table 3.2: Predictive models of active ageing for the total sample and stratified by gender

Variables	**OR**	**CI**	**p-value**
Total sample			
Gender	1.82	(0.99-3.32)	0.051
Diseases	1.46	(1.21-1.78)	<0.001
Education (years)	0.94	(0.91-0.98)	<0.01
Marital status	0.96	(0.56-1.66)	0.896
BMI	1.03	(0.95-1.12)	0.493
Arm circumference	0.98	(0.91-1.06)	0.581
Waist circumference	1.00	(0.97-1.03)	0.785
Men			
Diseases	1.69	(1.19-2.39)	<0.005
Education (years)	0.94	(0.88-0.99)	<0.01
Marital status	1.60	(0.50-5.11)	0.429
BMI	1.05	(0.88-1.24)	0.609
Arm circumference	0.95	(0.82-1.08)	0.417
Waist circumference	0.98	(0.93-1.03)	0.420
Women			
Diseases	1.35	(1.06-1.72)	<0.05
Education (years)	0.94	(0.89-1.00)	0.062
Marital status	0.88	(0.47-1.64)	0.680
BMI	1.02	(0.91-1.14)	0.802
Arm circumference	0.98	(0.89-1.08)	0.702
Waist circumference	1.02	(0.97-1.06)	0.494

3.1.2 Social disparities in health: the role of health behaviours (Papers II and III)

In Papers II (4.2) and III (4.3) we describe SE inequalities in dynamic balance and frailty in Spain, respectively. Moreover, we analyse how different health behaviours like physical activity, obesity, alcohol and tobacco consumption, are associated with such health disparities. Both studies have a cross-sectional design and include data on Spanish individuals. Although Paper II (4.2) uses data from ELEA and Paper III (4.3) from SHARE, it is expected that some general conclusions may arise from both studies.

On the one hand, Paper II (4.2) investigates the association between SES and dynamic balance and whether lifestyle factors explained any possible associations. The sample is formed by 448 non-disabled individuals -age range 54-75-, enrolled in the ELEA project. We obtained an objective dichotomous ("good/poor") measure of dynamic balance and used it as the dependent variable.

The main analysis in Table 3.3 shows that individuals with primary education had higher risk of poor dynamic balance, even after adjusting for age, gender, obesity, physical activity and income. In addition, obesity and sedentary/poor physical activity were related to poor dynamic balance.

Other results suggest a graded marginally significant association between household income and dynamic balance performance (not shown). However, the association is attenuated when adjusting for the covariates. Moreover, we also stratify the analysis by gender, as there are differences in balance, SES, health and lifestyles between men and women. However, estimates are similar for men and women in both education and income, suggesting that the associations between SES and dynamic balance is not modified by gender (data not shown).

On the other hand, Paper III (4.3) investigates educational differences in frailty phenotypes and whether obesity could explain any possible associations. The study is based on 2,319 community-dwelling Spanish adults over 50 years old, participating in W1 of SHARE.

We defined frailty phenotypes based on the validated SHARE's frailty criteria [52, 60]. Educational differences in frailty and its association with BMI -estimated by means of self-reports of height and weight- were evaluated using multinomial logistic regression analysis.

In line with previous results and compared to men, a larger proportion of

Table 3.3: ORs (95% CI) for poor dynamic balance by educational level, obesity, physical activity and income

	Poor dynamic balance OR (95% IC)
Educational level	
Superior	1.00
High school	1.85 (0.81-4.22)
Primary	2.30 (1.16-4.56)
No formal education	1.62 (0.72-3.64)
Obesity	
No	1.00
Yes	1.49 (0.90-2.48)
Physical activity	
Moderate / Vigorous	1.00
Light	1.45 (0.85-2.48)
Sedentary / Poor	2.89 (1.46-5.74)

Notes: Adjusted for gender, age, education, obesity, physical activity and income.

women experienced frailty (22.3% vs. 13.3%; p<0.001) and pre-frailty (50.4% vs. 46.5%; p<0.001), respectively. Figure 3.2 shows the distribution of frailty scores by BMI and stratified by educational background. Both underweight and obesity are associated with higher frailty scores, whereas there is an educational gradient in frailty scores (Figure 3.2).

Table 3.4 shows the main findings. After adjusting for all confounders, there is a significant educational gradient in frailty, where individuals with non-formal education show increased odds of a frailty phenotype than individuals with higher education. Moreover, obesity is significantly associated to frailty and the effect of the former is similar at all levels of education after testing for interaction effects (not shown).

3.1.3 Predictors of physical functional decline in Spanish adults (Paper IV)

In Paper IV (4.4) we evaluate the social, educational, health and behavioural predictors of physical FD between W1 and W2. This is a 2-year longitudinal study, based on 699 community-dwelling Spanish adults aged over 65 years

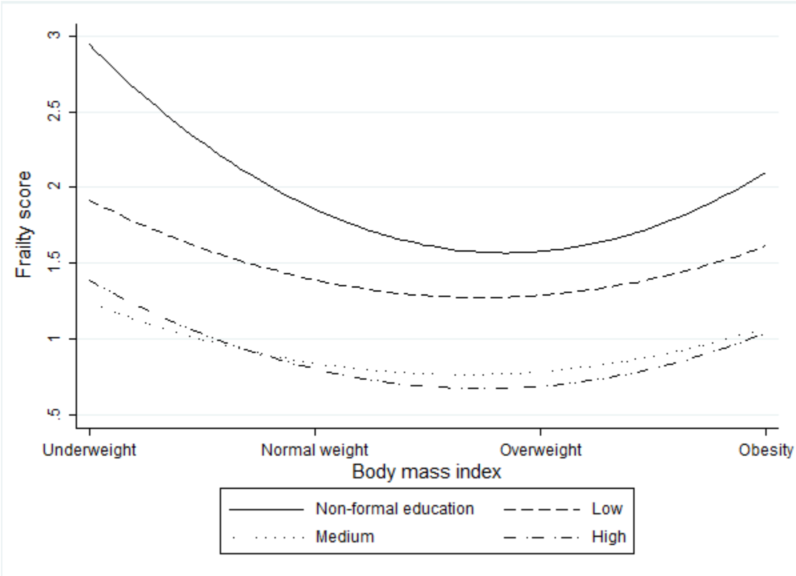

Figure 3.2: Distribution of frailty score (0-5) by BMI and educational level.

participating in SHARE.

We examine several baseline and longitudinal predictors of a combined measure of functional disability using logistic regressions. Table 3.5 shows the baseline factors associated with FD. There is an age dependent FD. There are gender differences in the association of baseline covariates and disability. Compared with women, older and poorly educated (low/primary) men are more likely to experience FD across waves. However, women reporting fair / poor health are more likely to experience FD than men.

Table 3.6 shows the decrease in general welfare in the covariates at follow-up, adjusting for confounders. FD in men is associated with an increased number of chronic diseases and depressive symptoms over a 2-year period, whereas among women it is associated with decreased numeracy score.

Table 3.4: ORs (95% CI) for pre-frailty and frailty phenotypes by educational level and BMI

	Pre-Frail OR (95% CI)	Frail OR (95% CI)
Education		
ref. (High)	1.0	1.0
Medium	0.9 (0.6-1.2)	1.4 (0.6-3.3)
Low	1.1 (0.8-1.7)	1.9 (0.8-4.2)
Non-formal	1.2 (0.8-1.8)	2.3 (1.0-5.4)
BMI		
ref. (Normal)	1.0	1.0
Underweight	3.1 (0.3-28.2)	5.0 (0.4-58.6)
Overweight	0.9 (0.7-1.1)	0.9 (0.6-1.3)
Obesity	1.2 (0.9-1.7)	1.8 (1.2-2.7)

Adjusted for gender, age, education, chronic conditions, ADL, IADL, SRHS, smoke and alcohol consumption and BMI.

3.1.4 Growth under poor health: long-term health implications in Europe (Paper V)

Based on data from SHARE, in Paper V (4.5) we analyse how poor health in childhood is associated with later life health within different European regions. Moreover, we assess whether both the exposure to different SE situations over the life course and contemporary health behaviours mediated that association, over a 6.6 year window. To summarise the health status during childhood we use self-reports of general health in childhood, which has been described as a good predictor of adult health [64,73]. As indicators of adult health, we use self-reported health in adulthood (SRHS), the number of chronic diseases/conditions diagnosed by a physician and the handgrip strength (kg).

Descriptive statistics indicate that poor childhood health is relatively rare (10%) and women have worse health during childhood than men ($p<0.05$) (not shown). Western Europeans exhibit the highest proportion of poor health in childhood, and subjects with poor health in childhood show worse indicators of adult health, like poorer SRHS, higher chronic conditions and lower grip strength. Those with poor health in childhood are more likely to live as single and have fewer children. In addition, they are more likely to have the lowest educational achievement and the lowest incomes. Finally, those with poor health

Table 3.5: Baseline factors associated with functional decline. Multiple logistic regression analyses with OR and 95% CI.

Variables	**Funct. decline** **Men**	**OR (95% CI)** **Women**	**Total**
Sociodemographic			
Age (at baseline)			
65-74	1.00	1.00	1.00
75-84	2.05 (1.10-3.84)	1.88 (1.14-3.08)	1.95 (1.32-2.87)
85+	4.18 (1.45-12.02)	1.75 (0.76-4.04)	2.33 (1.22-4.48)
Education			
Medium/High	1.00	1.00	1.00
Low	2.48 (1.06-5.80)	1.19 (0.53-2.68)	1.22 (0.69-2.17)
No formal educ.	1.25 (0.47-3.34)	0.63 (0.28-1.39)	1.47 (0.81-2.69)
Self-reported health			
SRHS			
Exc./V. good	1.00	1.00	1.00
Good	0.76 (0.30-1.93)	3.87 (1.09-13.74)	1.60 (0.78-3.30)
Fair	1.56 (0.62-3.93)	5.63 (1.63-19.49)	2.78 (1.37-5.62)
Poor	1.69 (0.49-5.78)	5.37 (1.44-20.04)	2.65 (1.18-5.94)
Symptoms[a]	1.21 (1.01-1.46)	1.11 (0.99-1.24)	1.14 (1.03-1.25)

[a]The number of medical symptoms present for at least the past 6 months at baseline; adjusted for age, sex, years of education, occurrence of heart attack/stroke and depression.

in childhood are more likely to be physically inactive but non-smokers. In summary, several SE indicators over the life course and adult health behaviours are associated with childhood health, highlighting the relevance of adjusting for these variables in regression analysis.

Table 3.7 shows the regression estimates for the three adult outcomes. Only the final models for every outcome are shown. We found a direct association between self-reports of poor childhood health and worse adult health outcomes, even after controlling for all covariates. Compared to those with good health, subjects with poor health in childhood show significantly worse SRHS, higher chronic conditions and lower grip strength in adulthood (Table 3.7).

Furthermore, we found long-term gender differences in poor childhood health exposure. Growing under poor health is a stronger predictor of adult SRHS in women than in men.

Additionally, the exhibited gradient for Models 2 (not shown) might indicate

Table 3.6: Odds ratios (95% CI) for functional decline by decrease in general welfare at follow-up.

Variables	Funct. decline Men	OR (95% CI) Women	Total
Self-reported health			
Δ SRHS			
no change/improved	1.00	1.00	1.00
decreased	1.69 (0.90-3.14)	1.32 (0.81-2.16)	1.46 (1.00-2.19)
Δ Chronic diseases			
no change/less	1.00	1.00	1.00
increased	2.25 (1.21-4.19)	1.33 (0.82-2.17)	1.63 (1.11-2.39)
Δ Symptoms			
no change/less	1.00	1.00	1.00
increased	3.66 (1.94-6.88)	2.36 (1.45-3.86)	2.81 (1.91-4.12)
Δ BMI			
no change/improved	1.00	1.00	1.00
worse	1.38 (0.59-3.24)	0.95 (0.49-1.83)	1.07 (0.63-1.79)
Cognitive functioning/ mental health			
Δ Orientation			
no change/improved	1.00	1.00	1.00
decreased	1.59 (0.70-3.62)	1.22 (0.65-2.27)	1.31 (0.80-2.14)
Δ Numeracy score			
no change/improved	1.00	1.00	1.00
decreased	1.71 (0.89-3.25)	1.88 (1.05-3.34)	1.81 (1.19-2.78)
Δ EURO-D			
no change/improved	1.00	1.00	1.00
decreased	5.05 (2.42-10.54)	1.89 (1.08-3.29)	2.74 (1.78-4.22)

Adjusted for age, sex, years of education, heart attack/stroke, depression and level of disability at baseline; SRHS: Self-reported health status, Orientation: Orientation test, Numeracy score: numeracy test, EURO-D: European Depression Scale.
Δ: change across time (Δ=W1-W2). If welfare status between W1 and W2 for all variables did not change/improved =0 (reference category); if decreases = 1. Worse BMI was established when individuals change their BMI category in W1 to a worse BMI category in W2 normal to underweight or normal to overweight or normal to obese or overweight to obese.

that poor childhood health is a stronger predictor of adult health in Northern countries. Figure 3.3 illustrates the described pattern for the country region-childhood health interaction for Models 2 (not shown).

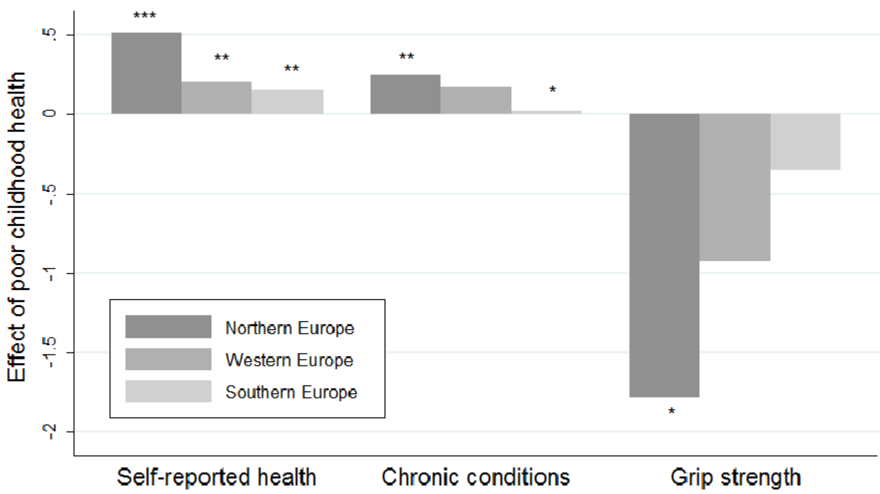

Figure 3.3: Regression coefficients for poor childhood health on regional-specific adult health, represented by SRHS, chronic conditions and grip strength in W4. Estimates correspond to Model 2 and controls for demographic characteristics and early life conditions. *p<.05; **p<.01; ***p<.001

Finally, poor childhood health predicts declines in SRHS over 6.6 years, while controlling for covariates attenuated the associations for changes over time in chronic conditions and grip strength (data not shown).

3.2 General discussion

The aim of this study was to evaluate biological and social factors associated with different health outcomes among older adults, and to provide consistent data on integrating gender/sex considerations throughout the life course. This PhD study was based on two research projects, ELEA and SHARE, each consisting on a rather large sample of community-dwelling older people. I believe the data and the study designs were appropriate for investigating the research questions, and that the original objectives were correctly addressed, by providing broad evidence on several determinants of adult health.

3.2.1 Discussion on the original papers

In Paper (4.1) we use a gender-based perspective for studying several factors associated to AA. The results of this paper might suggest distinctive associations for men and women. The differences observed in AA between men and women in relation to education are surely determined by a gender effect throughout the life course, mainly conditioned by access to education, home labours, etc. WHO's recommendations on this highlights the importance of promoting education as a determinant factor to achieve AA [8]. However, greater knowledge is needed to less-known health conditions that may differ between men and women. The lower perceived and objective health status of women compared with men could be due to inequalities in the physical and psychological burden associated with the care of elders/disabled people or family members and must be considered differentially, since these activities are mainly conducted by women [74]. However, there is a methodological issue that needs to be highlighted. There is no agreement on how to define AA, and also a controversy about the need to include elements that matter to older adults [75]. But independently on how to define it, there is also a debate about appropriate cut-off points in the measures used [12]. Some authors suggest that comparing the prevalences of active agers across studies may be of limited use given the wide variety of definitions and measurement approaches [12]. Moreover, when defining individuals into active and non-active agers, it is assumed that people cannot actively age with different chronic conditions [76]. For this reason, it may be appropriate to consider AA as a continuum, analysing how much someone ages actively would provide richer information than merely indicating whether someone is actively ageing or not. This approach, independently of the different dimensions and models used, would probably be a good initiative to board in future research.

In Papers II (4.2) and III (4.3) we addressed SE disparities in balance performance and frailty respectively, and whether health behaviours might explain such associations. To the well-known SE disparities in health in Spain, our studies add to the evidence on how health behaviours might contribute to those inequalities. Whereas some studies conclude that lifestyles make a relatively minor contribution to the social gradient in health [77], others have shown that differences in lifestyles can explain a relevant part of health inequalities [78,79].It has been shown, e.g., that both physical activity and BMI reduced SE disparities in functioning to some extent [80, 81] differently affecting men and women [82]. However, our study (Paper II (4.2)) does not show significant reduction in SE disparities in dynamic balance when controlling for obesity or physical activity, suggesting an independent effect of both SES and behavioural factors on balance performance. Similarly, in Paper III (4.3) we found that the effect of obesity does not vary within levels of education, which makes the contribution of the former to the odds of frailty phenotype somehow independent of the educational background, although there is a somehow mediation of obesity. The relevance of these findings relies on contributing to assess the importance of health behaviours in the magnitude of health inequalities. It has been suggested that risk factors are unequally distributed among the social classes and serve as potential pathways through which SES may influence health in older adults [83]. Our findings suggest that health behaviours like physical inactivity and obesity are not enough to explain the SE disparities in the studied outcomes, although no further considerations can be done due to the cross-sectional designs of the studies. The large SE differences in health in Spanish older adults make this type of studies very important in order to tackle health inequalities among older men and women, and longitudinal approaches are essential to accomplish that in future work.

In Paper IV (4.4) we studied the predictors of physical functional disability in older Spanish adults. We found that longitudinal changes in predictors are strongly associated with longitudinal changes in function between baseline and a 2-year follow up, most clearly among men. Although men reported better health than women, changes in SRHS were more strongly associated with decline in men. One possible interpretation is that health and symptoms are already so much worse for women than for men at baseline, that longitudinal changes for women are smaller than for men -due to ceiling effects. As a result, at any given age, change may appear to be a stronger predictor for the relatively healthier men, while the already poor levels of health at baseline may turn out to be stronger predictors for women. Our findings suggest that in addition to age, education and SRHS, the onset of symptoms, the onset of chronic diseases and depressive symptoms, and reduced cognitive functioning (numeracy score) are clinical predictors potentially useful in the prevention of disability in older Spanish adults. The prevention/delay of the onset of disability in older adults could have a positive impact on their quality of life [84]. Effective strategies are needed for the prevention of FD and our study provides tools for its clinical prediction, which may help reducing the incidence of disabilities and the period of dependence near the end of life and curb increasing trends in disability in the older Spanish population.

Finally, our study on the life course trajectories of health (Paper V (4.5)) showed interesting results. Overall, our results indicate that the impact of childhood health in adult health is direct, whereas the impact of childhood SES is more indirect, operating through own SES in adulthood. Our results are not inconsistent with what much of the previous literature stands, adding to the evidence on the importance of early life health in determining later life health [63–65, 85]. Based on this, our results support the notion that in order to improve old-age health, efficient interventions could be guided to first improve child health. Moreover, we found long-term gender differences in poor childhood health exposure. Growing under poor health is a stronger predictor of adult SRHS in women than in men, and our results may suggest that part of the excess in worse subjective health among women relative to men might have an early origin due to the traditional gender roles established early in life. This adds to the evidence of previous reports on gender health inequalities over the life course [16]. Finally, our findings suggest that the early exposure to poor health states may have more negative impact in Northern compared to Western and Southern European countries, as shown in Figure 3.3. To our knowledge, these findings provide the first regional-specific evidence of historical differences in the childhood-adult health association. Unfortunately, we cannot offer a straightforward substantive explanation for this result. What this finding may suggest, however, is that growing under poor health in Southern and Western countries would be more random and therefore, independent of SES, while in Northern countries this would represent a highly persistent state, involving being sickly throughout the life course, but this is largely speculative. Comparative studies have found that socioeconomic inequalities in mortality and morbidity are not smaller in countries with relatively universal and generous welfare policies (like Nordic countries) than they are in other countries (e.g. Southern European countries with their more family-based welfare arrangements) [86]. It has sometimes been argued that advanced welfare states may raise unrealistic expectations of a better life among people with a lower SE position -and consequently, poorer health-, and therefore induce higher levels of frustration and stress [86, 87]. We cannot exclude for interpretations, however, a possible bias due to cross-cultural differences in self-reported health. The image of "normal" health might differ among different societies [88] and this cross-cultural difference makes the consistency of the findings from international studies somehow less straightforward.

3.2.2 Implications and future directions

I believe that the results presented in the above mentioned studies may be useful for policy-makers when developing interventions focused on promoting health and preventing disability in older adults. Our five studies contribute to this in different ways. Although the cross-sectional designs of Papers I-III (4.1 4.2 4.3) do not allow to suggest causality and consequently, no further conclusions more than simple associations can be derived from them, findings from Papers IV (4.4) and V (4.5) provide more solid evidence that do enable to suggest interventions based on longitudinal evidences. Particularly, our results add to the evidence on the need to continue applying life course and gender-based approaches with longitudinal designs whenever possible in studies of health disparities among older adults. Our results and the growing evidence on the importance of the life course determinants of adult health, together with the historical gender and SE differences in access to education, income and healthy lifestyles, support these approaches.

It is worth mentioning that the results and possible implications presented here should be carefully considered. Thus, e.g., results derived from longitudinal analysis referring causality of the potential loss of functional capacity and the effect of childhood into adult health must be interpreted with caution. Overall and despite the limitations described in every paper, this study makes a valuable contribution to the knowledge on the SE determinants of adult health, by presenting gender-based evidences of disparities and health trajectories throughout the life course.

Future directions in life course research include the use of biomarkers as indicators of adult health. Physical and biological measurements as objective health data were so far mostly taken in smaller, non-representative clinical studies. But in the last couple of years more and more large-scale surveys added biomarkers to their programs, since there is a promising scientific value to it. The use of biomarkers will enable researchers to *i*) validate respondents' self-reports, *ii*) identify causal relationships and specific physiological pathways and help understanding the complex relationships between social status and health and *iii*) give pre-disease information: physiological processes are often below the individual's threshold of perception, but may be nevertheless predictive for ongoing or future diseases. [89]. At this moment, SHARE has released a pilot test in the German sub-sample and it is expected that in further waves it will cover the entire sample.

The understanding of gender inequalities in health is largely disconnected from the life course processes that precede them and the social contexts in which they unfold [90]. We contribute to address this, by describing long-term gender differences in poor childhood health exposure that suggest that part of the excess in worse subjective health among women relative to men might have an early origin due to the traditional gender roles established early in life. Future work would benefit from greater sensitivity to the role of gender and its intersection with life course experiences [91].

Table 3.7: Estimates for adult self-reported health, chronic conditions and grip strength. Only final models are represented.

Covariates	**SRHS**	**Diseases**	**Grip strength**
Health status when 10y(ref.=Good)			
Poor	0.474***	0.229**	-1.542[a]
Sex (ref.=Men) Women	0.027	0.080***	-15.811***
Health status when 10y*Sex (ref.=Good/Men)			
Poor*Women	0.164*	0.067	-0.573
Age at first interview	0.017***	0.023***	-0.469***
Countries (ref.=Northern)			
Western	0.431***	0.013	-1.901***
Southern	0.644***	0.147a	-5.617***
Health status when 10y*Countries (ref.=Good/Northern)			
Poor*Western	-0.278*	-0.054	0.732
Poor*Southern	-0.318*	-0.204*	1.285
Childhood SES (ref.=Other)Low	0.121[a]	0.059	0.307
Area of residence*Countries (ref.=Big city-subs./Northern)			
Rural area/Village*Southern	-0.028	0.134	2.126**
Living situation (ref.=Living with spouse/partner)			
Living as single	0.044	0.042[a]	-0.519*
Number of children	0.007	0.011	0.127*
Education (ref.=5^{th} quintile)			
4^{th} quintile	-0.011	-0.047	-0.379
3^{rd} quintile	0.063	-0.017	-0.116
2^{nd} quintile	0.156**	0.033	-0.829*
1^{st} quintile	0.206***	0.014	-0.723*
Income (ref.=5^{th} quintile)			
4^{th} quintile	0.093**	0.083*	0.069
3^{rd} quintile	0.149***	0.053	-0.394
2^{nd} quintile	0.207***	0.145***	-0.620*
1^{st} quintile	0.250***	0.112**	-0.745*
Obesity(BMI>30)(ref.=Other)Yes	0.275***	0.334***	0.050
Physical inact.(ref.=Other)Yes	0.447***	0.141***	-2.473***
Smoke(ref.=Other)Yes	0.087***	0.059**	0.047

Notes: Linear model for SRHS and grip strength; negative binomial model for chronic conditions. [a]p<.10; *p<.05; **p<.01; ***p<.001.

Main findings and Conclusions

The main findings of the present study can be summarised as follows:

1. The lower prevalence of AA and part of the worse subjective health among women relative to men may have an early origin, probably related to traditional gender roles established early in life, and mainly conditioned by access to education. This contributes to the knowledge on gender inequalities in health over the life course.

2. Health behaviours such as physical activity and obesity play a similar role in disparities in frailty and balance performance within different SE backgrounds, suggesting that they make a relatively minor contribution to the social gradient in health.

3. In addition to baseline predictors, the onset of symptoms, diseases and depressive symptoms, and reduced cognitive functioning are clinical predictors of FD potentially useful in the prevention of disability, which may help reducing its incidence and the period of dependence near the end of life.

4. There is a direct association between childhood and adult health, whereas the impact of childhood SES is more indirect, operating through own SES in adulthood. This suggests that in order to improve adult health, efforts can be made in ameliorating child health. This contributes to the understanding of the mechanisms underneath the health dynamics over the life course.

5. Poor childhood health is a stronger predictor of adult health -having more negative effect- in Northern compared to other European countries. This

finding may be useful for planning interventions based on country-specific evidence.

In conclusion, the results of the present study indicate that several physical and SE factors should be considered as important determinants of adult health and physical functional decline among community-dwelling older adults. In addition, our results suggest that life course perspectives addressing gender-health intersections are important and may offer effective means to promote adult health. Overall, the observations of the present study can be applied in help developing interventions leading to improve old-age health.

Original papers

4.1 Anthropometric, body composition and health determinants of active ageing: A gender approach

I

by

Pilar Montero López, Rocío Fernández-Ballesteros, María Dolores Zamarrón,
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Journal of Biosocial Science, 2011, 43: 597-610.

4.3 Educational inequalities and frailty in Spain: What is the role of obesity?

III

by

Santiago Rodríguez López, Pilar Montero, Margarita Carmenate.

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EDUCATIONAL INEQUALITIES AND FRAILTY IN SPAIN: WHAT IS THE ROLE OF OBESITY?

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Abstract: *Background:* Evaluate how obesity is associated with the development of frailty among older adults is important. However, few studies have examined the relation between obesity and frailty within different educational backgrounds. *Objectives:* This study aims to investigate the association between educational level and frailty and to evaluate whether obesity explains any possible associations among Spanish adults. *Design, participants and settings:* This is a cross-sectional study including 2,319 50-years-old and older community-dwelling Spanish adults, who participated in the first wave (2004/05) of the Survey of Health, Ageing and Retirement in Europe (SHARE). *Measurements:* Educational differences in frailty phenotypes –defined by the SHARE's operationalized criterion– and their association with obesity –estimated through self-reports of weight and height– were evaluated using multinomial logistic regression analyses. *Results:* Women experienced frailty in a larger proportion than men (22.3% vs. 13.3%). After adjusting for all confounders, we found a marked educational gradient in frailty, where individuals with non-formal education showed increased odds of a frailty phenotype than individuals with higher education. Moreover, obesity was significantly related to frailty and the effect of obesity is similar at all levels of education after testing for interaction effects. Although there is a mediation effect of obesity, the educational gradient in frailty is robust to controls for obesity. *Conclusions:* Our findings suggest a somehow independent effect of both educational background and obesity on frailty among Spanish individuals. This adds to the evidence of the frailty-obesity association among different educational backgrounds, and has implications for future interventions leading to reduce health disparities in elders.

Key words: Frailty, education, obesity, SHARE, Spain.

Introduction

Frailty is a common condition in older persons and has been described as a geriatric syndrome resulting from age-related cumulative declines across multiple physiological systems (1) and a good predictor of disability among older adults (2). It has been recently suggested that probably the most common phenotype of frailty in the near future will be characterized by the concurrent and interacting presence of obesity (3). Thus, the evaluation of the role of obesity in the development of frailty among older adults is one of the main gaps and future directions in frailty research (4).

Evaluating the importance of health behaviors such as obesity in the magnitude of health inequalities in older adults is important, as risk factors are unequally distributed among the social classes and serve as potential pathways through which socioeconomic status (SES) may influence adult health (5). Whereas some studies conclude that health behaviors make a relatively minor contribution to the social gradient in health (6), others have shown that differences in lifestyles can explain a relevant part of health inequalities (7-8). Previous studies have examined associations between SES and frailty (9,10-12), while others investigating the relationship between obesity and frailty have been comparatively minor (13-14). However, few studies have examined how obesity is related to frailty within different educational backgrounds.

Growing evidence suggests that obesity can exacerbate the age-related decline in physical function, which potentially causes frailty (15). Body mass index (BMI) may change in parallel with the development of frailty, and assessing how it relates –mainly through obesity– to frailty states among individuals within different SE backgrounds is relevant to frailty prevention/delay. This is particularly important in a country like Spain, where one of the largest life expectancies in Europe coexist with high levels of frailty, disability and obesity. This health paradox exists together with a great proportion of poorly educated older adults.

Within this context, the present study aims to i) identify potential educational inequalities in the prevalence of frailty phenotypes in Spanish adults and ii) evaluate whether obesity explains any possible association. Our study is appropriate by examining potential educational inequalities in frailty among the Spanish population, which exhibits a large proportion of older adults with poor educational background and one of the highest prevalences of disability and obesity within European countries.

Methods

Data

This is a cross-sectional study, focusing on 50-years-old and older Spanish individuals who participated in the first wave (W1) of the Survey of Health, Ageing and Retirement in

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Europe (SHARE), carried out in 2004/05. SHARE is a multidisciplinary cross-country longitudinal survey providing micro data on health, SES, and retirement of older Europeans. The details of the data collection and sampling procedures have been previously described (16). The response rate reached up to 53.3% for Spain (17). We included a relatively young population in order to assess pre-frailty in addition to frailty phenotypes. Originally, 30,816 individuals participated in W1 of SHARE. The Spanish subsample in W1 includes 2,396 participants. After excluding individuals with missing data for demographic characteristics and frailty states, our sample comprises 2,319 individuals (mean age 66.8 years old): 979 men (42.2%) and 1,340 women (57.8%).

Variables

Dependent variable

Frailty phenotype was used as the dependent variable in this study. We used the SHARE's definition of frailty described by Santos-Eggimann et al. (18), based on the following five conditions:

a) Exhaustion: identified as a positive response to the question: 'In the last month, have you had too little energy to do the things you wanted to do?'. A positive answer was recoded as 1, and a negative as 0.

b) Weight loss: this criterion was fulfilled by reporting a 'diminution in desire for food' in response to the question: 'What has your appetite been like?' or, in the case of a non-specific or uncodeable response to this question, by responding 'less' to the question: 'So, have you been eating more or less than usual?'. The presence of this criterion was coded as 1 and its absence as 0.

c) Weakness: assessed by handgrip strength (kg) using a dynamometer. Weakness was considered according to the cut-off points for grip strength criterion for frailty, stratified by gender and BMI (19).

d) Slowness: defined as a positive answer to either of the following two questions: 'Because of a health problem, do you experience difficulty (expected to last more than 3 months) walking 100 metres?' or '... climbing one flight of stairs without resting?' One or two positive answers received the score of 1, and two negative answers received the score of 0.

e) Low activity: assessed by the question: 'How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or going for a walk?'. Four possible answers were considered: 1='More than once a week'; 2='Once a week'; 3='One to three times a month' and 4='Hardly ever or never'. Low activity criterion was considered when a response of 3 or 4 was obtained.

The presence of frailty was defined following Fried's definition (20). An individual is considered frail when having at least three out of the five components of the frailty index. An intermediate or pre-frail phenotype corresponds to the presence of one or two of the conditions mentioned above. Previous studies (21) have validated the adapted criteria proposed by Santos-Eggimann (18). Among all the items available in SHARE, the above choice of variables is the closest possible selection to the original variables in Fried's phenotype. However, we acknowledge two significant departures from Fried's theoretical framework, such as 'weight loss' (replaced by appetite) and 'slowness' (measured by questions on functional limitation) (22).

Sociodemographic

Sociodemographic characteristics are summarized by gender, age, and level of education (23). Education has been recoded into four broad groups: none (no formal education, without distinguishing illiterate from non-illiterate individuals), low (primary school), medium (high school) and high (university studies).

Health variables and health behaviors

General health variables are represented by i) self-reported health (SRH), coded as a five-point continuous variable with 1=excellent and 5=poor; ii) the sum of self-reports of chronic conditions diagnosed by a physician (range 0-9); iii) the number of limitations in basic (ADL; range 0-6) and iv) instrumental (IADL; range 0-7) activities of daily living.

Health-related behaviors are represented by smoking, alcohol consumption and BMI. Smoking was categorized as 1=current/former vs. 0=never. Alcohol consumption 1=drinking more than 2 glasses of any alcoholic beverage 5/6 days a week, vs. 0=other. BMI was estimated from self-reports of weight and height and recoded into four groups: underweight (BMI<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2) and obese (BMI>30.0 kg/m^2).

Statistical analyses

Descriptive statistics were performed stratified by gender. Associations were tested between frailty phenotypes and sociodemographic characteristics, health variables and health-related behaviors. Multinomial logistic regression was used to analyze odds ratios (ORs) of pre-frail and frail phenotypes (outcomes) as a function of covariates. We estimated four different models: Model 1: unadjusted, including level of education and BMI; Model 2 adds gender and age to Model 1; Model 3 adds health variables and health-related behaviors to Model 1, but excluding BMI. Finally, Model 4 adds BMI to Model 3. The comparison of Models 4 and 3 demonstrates the confounding influence of BMI in the association between education and frailty, after adjusting for health variables and health-related behaviors. In addition to main effects, we also tested for interaction effects between level of education and categories of BMI, in order to show whether the effect of obesity is similar or varies at different levels of education.

We included ADL and IADL in order to control for disability. This allowed us to obtain disabled-free frailty outcomes, after controlling for the effect of physically impaired people. Even though from a conceptual point of view this is probably not the best way to control for disability –as frailty is supposed to increase its risk– we preferred this rather than excluding those disabled individuals from our sample.

Results

Compared to men, a larger proportion of women show frailty (22.3% vs. 13.3%) and pre-frailty phenotypes (50.4% vs. 46.5%, respectively) ($\chi2=55.6$; $p<0.001$; data not shown). Table 1 shows the distribution of the study characteristics by frailty phenotypes and stratified by gender. Compared to those who are non-frail, pre-frail and frail individuals are older, have fewer years of education –a larger proportion of them have a poorer educational level– more chronic conditions, ADL and IADL, and poorer SRH. On the other hand, they seem to have relatively healthier behaviors related to smoking and alcohol consumption, more apparent among women.

Figure 1 shows the distribution of frailty scores by categories of BMI and stratified by educational background. Both underweight and obesity are associated with higher frailty scores, whereas there is an educational gradient in frailty scores.

Table 2 describes the ORs of both pre-frail and frailty phenotypes by educational level and BMI. The crude analyses show a marked educational gradient in pre-frail and frailty phenotypes (Model 1). After adjusting for gender and age (Model 2) the associations are markedly attenuated, but remain statistically significant. Adjusting for possible confounders (Model 3) and BMI (Model 4) attenuate the associations for the pre-frail phenotype to a non-significant statistical level, while a poorer education stays significantly associated to frailty phenotype in the fully adjusted model (Model 4).

The analysis for interaction effects between level of education and categories of BMI was not statistically significant, indicating a homogenous effect of obesity at all levels of education (data not shown). We found that obesity remains associated to the frailty phenotype in the fully adjusted model (Model 4), while such association was attenuated for the pre-frailty phenotype, after adjusting for all confounders. On the other hand, compared to individuals with normal weight, overweighed people seemed to have a lower risk associated to pre-frailty and frailty phenotypes, although not significantly.

Discussion

Our purpose was to assess potential educational differences in frailty phenotype in 50-year-old and older community-dwelling Spanish adults, and to evaluate to what extent BMI –mainly through obesity– could explain such an association.

Table 1
Study characteristics by frailty states and stratified by gender

	Overall	Men				Women			
		Non-frail (N = 394)	Pre-frail (N = 455)	Frail (N = 130)	p-value[a]	Non-frail (N = 366)	Pre-frail (N = 675)	Frail (N = 299)	p-value[a]
Age	66.8 (10.6)	63.1 (8.6)	67.8 (10.0)	73.6 (10.2)	<0.001	62.1 (8.7)	66.4 (10.7)	73.8 (10.8)	<0.001
Education (years)	6.5 (4.3)	7.7 (4.3)	6.8 (4.7)	5.2 (4.0)	<0.001	7.8 (4.1)	6.1 (4.0)	3.8 (3.6)	<0.001
Non-formal education	20.9	13.0	20.1	31.8	<0.001	12.1	20.8	38.5	<0.001
Low	46.8	40.1	46.7	51.9		42.0	52.0	47.8	
Medium	25.2	36.0	23.9	10.9		36.5	22.3	12.4	
High	7.1	11.0	9.3	5.4		9.3	4.9	1.3	
Number of chronic conditions (0 - 9)	1.9 (1.6)	1.2 (1.2)	1.8 (1.5)	2.7 (1.9)	<0.001	1.2 (1.2)	2.0 (1.6)	3.1 (1.7)	<0.001
ADL (0 - 6)	0.3 (1.0)	0.0 (0.1)	0.3 (0.9)	1.0 (1.7)	<0.001	0.0 (0.1)	0.3 (1.0)	1.0 (1.5)	<0.001
IADL (0 - 7)	0.6 (1.4)	0.1 (0.3)	0.4 (1.3)	1.6 (2.3)	<0.001	0.1 (0.4)	0.5 (1.3)	1.6 (1.9	<0.001
SRH (1 Excellent - 5 Poor)	3.4 (1.0)	2.8 (0.8)	3.3 (0.9)	4.1 (0.9)	<0.001	2.9 (0.8)	3.4 (0.9)	4.1 (0.7)	<0.001
BMI									
Underweight	0.6	0.0	0.2	4.0	<0.001	0.3	0.8	0.4	<0.001
Normal weight	30.4	25.0	27.6	32.8		41.0	32.0	24.1	
Overweight	44.9	55.3	49.8	42.4		42.4	40.9	36.3	
Obesity	24.0	19.5	22.4	20.8		16.3	26.4	39.2	
Current smoking (yes)	15.2	27.7	26.6	17.7	0.070	10.7	7.5	2.7	<0.001
Alcohol consumption (yes)	14.8	34.4	26.6	14.6	<0.001	9.3	4.3	2.0	0.011

a χ^2 and ANOVA/t-test or non-parametric analyses for each particular case; ADL: limitations in basic activities of daily living; IADL: limitations in instrumental activities of daily living; SRH: self-reported health; BMI: Body Mass Index; Alcohol consumption: drinking more than 2 glasses of any alcoholic beverage 5/6 days a week.

Table 2
ORs (95% CI) for pre-frailty and frailty states by educational level and BMI

	Pre-Frail OR (95% CI)				Frail OR (95% CI)			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Education								
ref. (= High)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Medium	0.9 (0.7 - 1.4)	0.9 (0.6 - 1.3)	0.9 (0.6 - 1.3)	0.9 (0.6 - 1.2)	1.4 (0.7 - 2.9)	1.4 (0.7 - 3.0)	1.3 (0.6 - 2.8)	1.4 (0.6 - 3.3)
Low	1.8 (2.3 - 1.5)	1.4 (1.0 - 2.0)	1.2 (0.8 - 1.7)	1.1 (0.8 - 1.7)	5.0 (2.5 - 10.0)	2.5 (1.2 - 5.2)	1.8 (0.8 - 3.8)	1.9 (0.8 - 4.2)
Non-formal	2.3 (1.5 - 3.4)	1.6 (1.0 -2.4)	1.2 (0.8 - 1.9)	1.2 (0.8 - 1.8)	11.7 (5.7 - 24.0)	4.5 (2.1 - 9.5)	2.2 (1.0 - 5.0)	2.3 (1.0 - 5.4)
BMI								
ref. (= Normal)	1.0	1.0	.	1.0	1.0	1.0	.	1.0
Underweight	4.4 (0.5 - 37.5)	3.5 (0.4 - 30.1)	.	3.1 (0.3 - 28.2)	12.3 (1.4 - 109.2)	7.1 (0.7 - 67.8)	.	5.0 (0.4 - 58.6)
Overweight	0.9 (0.7 - 1.1)	0.9 (0.7 - 1.2)	.	0.9 (0.7 - 1.1)	0.8 (0.6 - 1.1)	0.9 (0.7 - 1.3)	.	0.9 (0.6 - 1.3)
Obesity	1.3 (1.0 - 1.8)	1.4 (1.1 - 1.9)	.	1.2 (0.9 - 1.7)	1.7 (1.2 - 2.5)	2.2 (1.5 - 3.2)	.	1.8 (1.2 - 2.7)

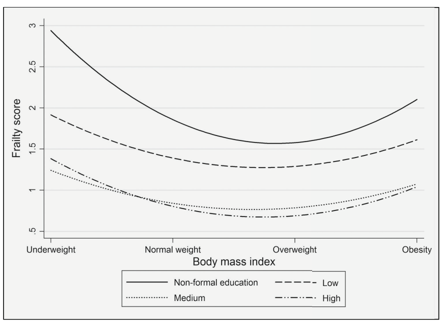
Non-frail participants (not shown) are considered as the referent category. Model 1: crude odds ratios for the association between level of education and BMI, respectively, with frailty phenotype; Model 2: Adds gender and age to Model 1; Model 3: Adjusted for gender, age, level of education, number of chronic conditions, ADL, IADL, SRH, smoke and alcohol consumption; Model 4: Adjusted for gender, age, level of education, number of chronic conditions, ADL, IADL, SRH, smoke and alcohol consumption and BMI.

We found marked educational differences in pre-frail and frailty phenotypes: those with a lower educational background showed increasing likelihood of being frail, even after adjusting for all confounders, including obesity. Furthermore, the effect of obesity is similar at all levels of education after testing for interaction effects. Although there is a mediation effect of obesity, the educational gradient in frailty is robust to controls for obesity, which may suggest a somehow independent effect of both educational background and obesity on frailty individuals.

In line with previous studies (9,18) we found that, compared to men, a larger proportion of women showed pre-frail and frailty. It has been hypothesized that the higher incidence of frailty among women may be partly due to the marked gender roles still present in older people, for which most women had a restrained social life and little economic independence (24). Moreover, we found educational differences in frailty in our sample. Adjusting for confounders attenuated the associations for the pre-frailty phenotype. In the case of Spain, the large educational differences seem to make education a good indicator of SES that may reflect living conditions, life chances, etc., associated to differences in health (25). Thus, it was expected that these inequalities were differently related to frailty phenotypes among men and women. This finding is in line with general evidence that less educated persons are at increased risk of experiencing frailty (9-10). Although previous research suggests that education contributes to differences in frailty and pre-frailty in most European countries (18), it is important to establish whether such associations are consistently found or are specific to certain countries.

The association between BMI and frailty has been previously described as a U-shaped curve (14): frailty scores are lowest in those with normal weight and overweight individuals, and higher in those with underweight and in those with obesity. We found similar results in the case of Spain (Figure 1), although the low proportion of low BMI (underweight) in the sample conditions the measurement of frailty (0% for most groups, and only 4% in the frail group). However, the low proportion of underweight may indicate that weight loss is not a big issue in this population.

Figure 1
Frailty score (range 0 - 5), body mass index and educational background in the study sample. Low, medium and high educations correspond to primary, high school and university studies, respectively



Obesity was associated with pre-frail and frailty phenotypes, and these associations remained also for frailty after controlling for sociodemographic characteristics, health-related variables and health behaviors. Similar findings were previously reported (13). In spite of the fact that there may be differences in findings between our study and others due to both the use of different methods for measuring frailty and the adults' age considered, obesity also seems to be associated with the frailty syndrome in other cross-sectional studies (14). Similar findings were observed in another study where obesity was related to frailty in women but not in men, suggesting that differential exposure and vulnerability over the life course may partially explain differences between men and women (10). Our results suggest that in Spain obesity is similarly associated to different levels of education, which made the contribution of the former to the odds of pre-frailty and frailty somehow independent of the educational background.

Several limitations need to be highlighted. Probably the most important limitation of this study is the use of self-reports of weight and height to estimate BMI. Despite the large amount of evidence regarding the appropriateness of using self-reported data to estimate nutritional status (26), its use might result in an underestimation of BMI, since Spanish adults seem to over-report higher heights than other Europeans (27). Assuming this as true, our findings related to the association between obesity and frailty could be hampered, but in any case they may be underestimated. Similarly, SHARE's definitions of frailty (18) rely considerably on self-report data, which forms the basis for four out of five items (i.e. all except handgrip strength). The differences between the definition of frailty used in this study and Fried's criteria have already been described (18) and there is no guarantee that ours actually measures the same as Fried's definition of frailty. Consequently, our findings may not be totally comparable to others using Fried's criteria, although recent evidence support the use of SHARE's operationalized frailty approach (21, 28).

Moreover, the cross-sectional design does not allow us to treat the factors considered as causal, as they may simply occur together with frailty phenotypes. More prospective studies are needed to elucidate the specific role of obesity in order to prevent the onset and development of frailty, particularly among poorly educated women. This could have a positive impact on their quality of life, by reducing the incidence of disabilities and the period of dependence near the end of life. Encouragement of older men and women to maintain or increase their regular exercise can help to lose weight (1) and reduce obesity, which in turn may help prevent the onset of frailty. Despite the limitation of our data, our study provides evidence on how obesity and educational differences are associated in frailty, leading towards curbing existing trends in health inequalities in the adult Spanish population. Further studies in this area, especially in countries where SE inequalities in health have been examined less –including Spain– are therefore justified.

In conclusion, we have evaluated the association between educational attainment and frailty in Spanish adults and whether obesity could explain such association. We found a graded educational inequality associated to pre-frail and frail phenotypes: those with lower educational background showed an increasing likelihood of being frail, even after adjusting for all confounders, including obesity. The fact that the influence of obesity was similar at all levels of education suggests an independent effect of both education and obesity on frailty. These findings add to the evidence of the frailty-obesity association among different educational backgrounds and have implications for future interventions leading to reduce health disparities among older adults. The association of obesity with higher odds of frailty supports the notion that for preventing or retarding frailty, benefits can be obtained by promoting regular exercise among older individuals.

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4.4 Functional decline over 2 years in older Spanish adults: Evidence from the Survey of Health, Ageing and Retirement in Europe

IV

by

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Functional decline over 2 years in older Spanish adults: Evidence from the Survey of Health, Ageing and Retirement in Europe

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Aim: To evaluate the social, educational, health and behavioral predictors of physical functional decline in older Spanish adults.

Methods: A 2-year longitudinal study based on 699 community-dwelling Spanish adults aged over 65 years participating in the Survey of Health, Ageing and Retirement in Europe was carried out. Several predictors of a combined measure of functional disability were examined using logistic regressions.

Results: A decline in function was experienced by 166 individuals. Functional decline in men was associated with an increased number of chronic diseases (OR 2.25, 95% CI 1.21–4.19) and depressive symptoms (OR 5.05, 95% CI 2.42–10.54) over a 2-year period, whereas among women it was associated with decreased numeracy score (OR 1.88, 95%CI 1.05–3.34).

Conclusions: Longitudinal changes in predictors are strongly associated with longitudinal changes in function between baseline and a 2-year follow up, most clearly among men. A decrease in cognitive functioning and increased depressive symptoms are associated with a decline in physical functioning, and can serve as useful clinical predictors to prevent disability in older Spanish adults. **Geriatr Gerontol Int 2013; ••: ••–••.**

Keywords: disability, functional decline, Survey of Health, Ageing and Retirement in Europe, Spanish adults, 2-year follow up.

Introduction

Functional decline is one of the most common features associated with aging.[1,2] The maintenance of functional capacity has been shown to be an important factor of mortality in older adults, and the loss of this capacity is associated with higher morbidity.[3] As in other Mediterranean countries, Spain has a higher life-expectancy and lower mortality rates than most other European countries.[4] However, despite the fact that in the past few decades disability has decreased in older Spanish individuals,[5] estimates of prevalence of disability among people aged over 65 years are higher than in other European and North American countries.[6] Except for advanced age,[7] many risk factors that have been associated with functional decline and disability in old age are potentially modifiable, including decreased physical activity, depression, extremes in body mass index (BMI), poor self-perceived health and smoking history.[3,8,9] Evidence suggests that trends in disability might also be reversible through increases in educational attainment, a reduction in social and sex inequalities, the adoption of healthy lifestyle habits, and changes in the physical and social environment to encourage active aging.[10]

Previous studies have examined associations between health and disability measures, but few studies have examined how broader social, educational and behavioral determinants are related to functional decline in Spain. Millán-Calenti *et al.* described associations between functional dependence in basic activities of daily living (ADL) and in instrumental activities of daily living (IADL) with morbidity in older Spanish people.[7] Previous studies have described trends in disability and

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changes in functional status in community-dwelling old[5,6,11,12] and very old[13,14] Spanish people, identifying factors that predict functional change. Most of these studies, however, analyzed the determinants of functional status using cross-sectional data. A comprehensive examination of the predictors of changes in functional decline in older Spanish adults based on longitudinal data is not yet available.

A better understanding of the process of functional decline in the elderly is useful for clinical prediction.[2] Longitudinal data provides the opportunity to examine changes in functional states and evaluate their potential predictors.[6] Although these predictors might change parallel to physical functioning, so that no causal relationship can be established, assessing how they relate to disability will provide a useful clinical tool to identify older adults at increased risk of faster functional decline. This will enable practitioners to develop early interventions that might prevent functional decline in Spanish older adults at increased risk.

The present study sought to identify the social, educational, health, and behavioral predictors of physical function and functional decline over a 2-year window among older Spanish adults aged 65 years and older. The present study is innovative by examining how both baseline and 2-year changes in predictors relate to changes in functional decline, and by assessing a wide array of potential predictors across multiple domains.

Methods

Data

Data come from the first (W1) and second (W2) waves of the Survey of Health, Ageing and Retirement in Europe (SHARE) collected in 2004 and 2006, respectively. SHARE is a multidisciplinary, cross-country, longitudinal survey providing microdata on health, socioeconomic status and retirement of individuals aged ≥50 from 15 European countries. The details of the data collection and sampling procedures have been previously described.[15,16]

In particular, this is a 2-year longitudinal study, focusing on individuals participating in W1 (baseline) and in W2 (follow up) in Spain. Originally, 1252 Spanish individuals aged ≥65 participated in W1. In W2, together with 407 lost (attrition = 32.5%) and 80 deaths (6.3%), a total of 765 participants were available. We excluded individuals who were missing data at baseline on age, number of ADL and IADL limitations. Our sample finally includes 699 individuals (mean age at baseline 74.3 years), 308 men (44.1%) and 391 women (55.9%), participating in both waves.

As previously reported,[17] the main reason for attrition in SHARE was lost to follow up because of participants moving out without leaving any contact information behind, so they could not be recontacted or they refused to participate in W2. In Spain, specific reasons for attrition were the length of interview and differences of education between the respondent and the interviewer: those with a short interview in W1 and those who were more educated than the interviewer were less likely to be interviewed in W2. To account for attrition and non-response bias, in sensitivity analyses, we replicated all analyses using calibrated longitudinal weights provided by SHARE and designed to compensate for attrition between W1 and W2. These weights control for the inverse probability of being included in each wave. Weighed analyses were very similar to analyses without using weights, suggesting that attrition was not a major source of bias in the present study. We therefore present weighted analyses only.

Measures

Most of the following variables were registered both at baseline and follow up.

Sociodemographic

Sociodemographic characteristics are summarized by sex, age, living arrangements (living as single or with spouse/non-relative) and education. The level of education was measured based on the highest level of education reported, and translated into the International Standard Classification of Educational Degrees.[18] We recoded educational level into three broad groups: none (no formal education, without distinguishing illiterate from non-illiterate individuals), low (primary school) and medium/high education (high school/university studies). These last categories were grouped due to the small number of individuals with high education.

Self-reported health

Represented by: self-reported health status (SRHS; 1 = excellent, 2 = very good, 3 = good, 4 = fair and 5 = poor); the number of chronic diseases/conditions, calculated as the sum of affirmative self-reports to the following conditions (if diagnosed by a doctor): (i) heart attack or myocardial infarction or coronary thrombosis or any other heart problem including congestive heart failure; (ii) high blood pressure or hypertension; (iii) high blood cholesterol; (iv) stroke or cerebral vascular disease; (v) diabetes or high blood sugar; (vi) chronic lung disease, such as chronic bronchitis or emphysema; (vii) asthma; (viii) arthritis, including osteoarthritis or rheumatism; (ix) osteoporosis; (x) cancer or malignant tumor, including leukemia or lymphoma, but excluding minor skin cancers; (xi) stomach or duodenal ulcer, peptic ulcer; (xii) Parkinson's disease; (xiii) cataracts;

(xiv) hip fracture or femoral fracture; (xv) other fractures; (xvi) Alzheimer's disease, dementia or senility; (xvii) benign tumor; and (xviii) other conditions; the number of medical symptoms present for at least the past six months, weight and height. BMI was estimated from self-reported weight and height, and recoded into four groups:[19] underweight (BMI < 18.5), normal weight (18.5–24.9), overweight (25.0–29.9) and obese (BMI > 30.0).

Cognitive functioning and mental health

Orientation to date, month, year and day of the week (orientation), and a mathematical performance (numeracy score) were used to assess cognitive functioning. Mental health status was measured by the Euro-Depression (EURO-D) scale, a discrete measure of depressive symptoms. The score ranges from 0 to 12, with higher scores indicating higher levels of depression.[20]

Health behaviors

Represented by self-assessed physical inactivity, smoking and alcohol consumption. Physical inactivity was defined based on self-reports of never or hardly ever engaging in moderate (gardening, washing the car or walking) or vigorous (such as sports, heavy housework or physical labor) physical activities; smoking was categorized as current/former or never. Alcohol consumption was considered when drinking more than two glasses of any alcoholic beverage 5–6 days a week.

Change in functional disability

Change in functional disability levels across waves was used as the dependent variable in the present study. Functional disability was defined as a composite index of ADL and IADL scales. ADL are defined as those activities essential for independent living, whereas IADL is more complex and requires a higher level of personal autonomy, referring to tasks implying enough capacity as to make decisions, as well as a greater interaction with the environment.[21] Based on these differences, deficits in the IADL normally precede deficits in the ADL.[22] Limitations in ADL (or IADL) were defined as having difficulty with and/or receiving help from another person or being unable to do one or more of the following items: dressing, walking across a room, bathing or showering, eating/cutting up food, getting in or out of bed, using the toilet – including getting up/down. Similarly, IADL include seven activities: (i) difficulties in using a map in a strange place; (ii) preparing a hot meal; (iii) shopping for groceries; (iv) making telephone calls; (v) taking medications; (vi) doing work around the house/garden; and (vii) managing money, paying bills and keeping track of expenses. Disability levels were categorized as none (not disabled), mild (IADL limitations only), moderate (1–2 ADL limitations) and severe (3–5 ADL limitations).[23] Changes in disability levels were then dichotomized into functional decline (FD; =1, if disability level in W2 increased relative to W1 level) or no change/improvement (=0, if disability level in W2 decreased or remained unchanged compared with that of baseline) and used as the outcome in further analyses.

Change across time in covariates

We estimated the significance of both baseline and changes across time in the covariates ($\Delta = \text{W1-W2}$) associated with FD; changes (Δ) in self-reported health, together with cognitive functioning and mental health were analyzed. Variables were all dichotomized into decrease and no change/improvement depending on whether they decreased, or did not modify/improve the general welfare in follow up.

Statistical analyses

Statistical analyses were carried out both for the total population and stratified by sex. Paired-samples *t*-test was used to analyze changes across time in physical functioning measures. Bivariant associations were tested between FD with sociodemographic characteristics, self-reported health, functional status, cognitive functioning/mental health and health behaviors, stratified by sex.

Multiple logistic regression was used to analyze odds ratios (OR) of FD (outcome) as a function of covariates in the estimated model. In the last analysis, changes in covariates at follow up were included. All analyses were carried out using PASW Statistics 18.0 (SPSS, Chicago, IL, USA).

Results

Table 1 shows the distribution of characteristics at baseline and follow up. More than half of the study sample at baseline was limited in activities, with a higher prevalence of IADL limitations. The frequency of individuals with limitations in ADL and IADL after 2 years was higher than at baseline for all measures.

Those lost to follow up were more likely to be women, live alone, had more years of education and IADL limitations. However, sample participants were not different from those lost to follow up in most study characteristics, including self-reported health, ADL limitations, cognitive function/mental health and health behaviors.

Table 1 Descriptive analyses at baseline and follow up

Variables	W1 (baseline)			W2 (follow up)			*P*-value†	Alive in W2 but lost to follow up (*n* = 407)	*P*-value‡
	n	Mean (SD)/%	Range	*n*	Mean (SD)/%	Range			
Sociodemographic									
Age	699	74.3 (6.4)	65.0–102.7	699	76.8 (6.4)	67.1–104.3	<0.001	75.1 (6.9)	0.066
Sex (female %)	699	55.9	.	.	.	.	.	62.9	0.023
Living as single (%)	699	28.2	.	.	.	.	.	43.5	<0.001
Years of education	695	5.0 (4.1)	0–17	.	.	.	.	5.7 (4.0)	<0.005
Self-reported health									
SRHS (1 excellent–5 poor)	694	3.5 (1.0)	0–5	699	3.8 (0.9)	0–5	<0.001	3.6 (0.9)	0.080
Chronic diseases	694	2.3 (1.7)	0–9	699	2.2 (1.6)	0–9	0.531	2.2 (1.7)	0.633
Medical symptoms	695	2.2 (2.1)	0–10	699	2.4 (2.3)	0–11	0.096	2.2 (2.0)	0.795
BMI	647	27.7 (4.3)	17.3–45.7	625	27.7 (4.5)	16.0–49.9	0.890	24.5 (9.3)	<0.001
Functional status									
ADL	694	0.4 (1.0)	0–6	698	0.6 (1.5)	0–6	<0.001	0.5 (1.4)	0.165
1+ADL limitations	694	18.7	.	698	22.3	.	.	16.7	0.401
IADL	694	0.7 (1.4)	0–7	698	1.0 (1.9)	0–7	<0.001	0.9 (1.7)	0.007
1+IADL limitations	694	30.7	.	698	32.6	.	.	40.6	<0.005
Limited with activities	696	56.2	.	699	58.1	.	.	52.1	0.192
Cognitive functioning/mental health									
Orientation (0 bad–4 good)	689	3.5 (0.9)	0–4	694	3.3 (1.2)	0–4	<0.001	3.3 (1.2)	0.121
Numeracy score (1 bad–5 good)	691	2.1 (1.0)	1–5	691	2.1 (1.0)	1–5	0.597	2.1 (1.0)	0.641
EURO-D scale	674	3.5 (2.8)	0–12	657	3.3 (2.8)	0–12	0.054	3.4 (2.8)	0.361
Health behaviors									
Physical inactivity	694	16.3	.	699	25.5	.	.	18.2	0.415
Ever smoke daily	694	33.0	.	.	.	.	.	28.7	0.138
Alcohol consumption	694	13.5	.	.	.	.	.	10.0	0.082

†Comparison between the first wave (W1) and second wave (W2). ‡Comparison of W1 respondents and those alive in W2 but lost to follow up. Alcohol consumption >2 glasses, 5–6 days a week. ADL, activities of daily living; BMI, body mass index; EURO-D, Euro-Depression scale (0 not depressed–12 very depressed); IADL, instrumental activities of daily living; SRHS, Self Rated Health Status.

Table 2 Descriptive analyses at baseline by occurrence of functional decline, stratified by sex

Variables	Functional decline	Men *n*	Mean (SD)/%	*P*-value	Women *n*	Mean (SD)/%	*P*-value
Sociodemographic							
Age (years)	No	246	72.9 (5.5)	<0.001	281	74.2 (6.7)	<0.005
	Yes	59	76.4 (7.1)		107	76.3 (6.6)	
Living as single	No	246	12.2	0.103	281	37.4	0.237
	Yes	59	20.3		107	43.9	
Years of education	No	244	5.8 (4.7)	0.410	279	4.7 (3.6)	0.018
	Yes	59	5.4 (3.2)		107	3.7 (3.7)	
Self-reported health							
SRHS (1 excellent–5 poor)	No	246	3.2 (0.9)	0.017	281	3.5 (1.0)	<0.001
	Yes	59	3.5 (0.9)		107	3.9 (0.8)	
No. chronic diseases	No	246	1.9 (1.5)	0.068	280	2.4 (1.7)	0.033
	Yes	59	2.3 (1.4)		107	2.8 (1.8)	
No. medical symptoms	No	246	1.4 (1.6)	<0.005	281	2.6 (2.2)	<0.005
	Yes	59	2.1 (1.7)		107	3.4 (2.3)	
BMI	No	237	27.2 (3.8)	0.936	254	28.0 (4.5)	0.486
	Yes	54	27.1 (4.0)		100	28.4 (5.1)	
Functional status							
1+ADL limitations	No	246	15.4	0.486	281	24.2	0.048
	Yes	59	11.9		107	15.0	
1+IADL limitations	No	246	19.9	0.604	281	40.6	0.458
	Yes	59	16.9		107	36.4	
Limited with activities	No	246	42.7	0.021	281	59.8	0.006
	Yes	59	59.3		107	68.4	
Cognitive functioning/mental health							
Orientation (0 bad–4 good)	No	244	3.7 (0.8)	0.203	278	3.4 (1.0)	0.164
	Yes	59	3.5 (0.8)		107	3.3 (1.1)	
Numeracy score (1 bad–5 good)	No	244	2.5 (1.1)	0.022	280	1.9 (0.9)	0.097
	Yes	59	2.1 (1.0)		107	1.7 (0.8)	
EURO-D scale (0 not depressed–12 very depressed)	No	241	2.2 (2.1)	0.683	268	4.2 (2.8)	<0.001
	Yes	59	2.4 (1.8)		105	5.4 (3.0)	
Health behaviors							
Physical inactivity	No	246	11.0	0.053	281	18.1	0.453
	Yes	59	20.3		107	21.5	
Ever smoke daily	No	246	66.7	0.092	281	5.0	0.603
	Yes	59	78.0		107	3.7	
Alcohol consumption	No	246	27.2	0.584	281	4.3	0.103
	Yes	59	23.7		107	0.9	

Alcohol consumption >2 glasses, 5–6 days a week. EURO-D, Euro-Depression scale (0 not depressed–12 very depressed); BMI, body mass index; SRHS, Self Rated Health Status.

Table 2 shows the differences in variables at baseline between those who had experienced FD at follow up and those who did not, separated by sex. Compared with those who improved or did not modify their disability level across waves, individuals with FD were older, had poorer SRHS and a higher number of symptoms.

Women had a higher prevalence of FD (27.6%) than men (19.3%). Compared with men without FD, men who experienced FD have lower numeracy, and a larger proportion of them were physically active. Women who experienced FD had fewer years of education, more chronic diseases and higher EURO-D scores. They were also more likely to be physically inactive, but they reported healthier behaviors related to smoking and alcohol consumption.

Table 3 shows baseline factors associated with FD by sex and for the total sample. Adjusted OR for FD by the described covariates are shown.

Table 3 Baseline factors associated with functional decline. Multiple logistic regression analyses with odds ratios and 95% confidence intervals

Variables	Functional decline OR (95% CI)		
	Men	Women	Total
Sociodemographic			
Age at baseline (years)			
65–74	1.00	1.00	1.00
75–84	2.05 (1.10–3.84)	1.88 (1.14–3.08)	1.95 (1.32–2.87)
85+	4.18 (1.45–12.02)	1.75 (0.76–4.04)	2.33 (1.22–4.48)
Living arrangements			
With spouse/non-relative	1.00	1.00	1.00
Living as single	1.53 (0.68–3.23)	0.97 (0.58–1.63)	1.04 (0.67–1.61)
Education			
Medium/high	1.00	1.00	1.00
Low	2.48 (1.06–5.80)	1.19 (0.53–2.68)	1.22 (0.69–2.17)
No formal education	1.25 (0.47–3.34)	0.63 (0.28–1.39)	1.47 (0.81–2.69)
Self-reported health			
SRHS			
Excellent/very good	1.00	1.00	1.00
Good	0.76 (0.30–1.93)	3.87 (1.09–13.74)	1.60 (0.78–3.30)
Fair	1.56 (0.62–3.93)	5.63 (1.63–19.49)	2.78 (1.37–5.62)
Poor	1.69 (0.49–5.78)	5.37 (1.44–20.04)	2.65 (1.18–5.94)
Chronic diseases			
No. chronic diseases†	1.15 (0.92–1.42)	1.08 (0.93–1.26)	1.10 (0.97–1.25)
Less than 2	1.00	1.00	1.00
2+	1.54 (0.81–2.91)	1.28 (0.74–2.21)	1.41 (0.93–2.13)
Symptoms			
No. symptoms‡	1.21 (1.01–1.46)	1.11 (0.99–1.24)	1.14 (1.03–1.25)
Less than 2	1.00	1.00	1.00
2+	1.64 (0.88–3.05)	1.29 (0.75–2.21)	1.45 (0.97–2.18)
BMI			
Underweight/normal weight	1.00	1.00	1.00
Overweight	0.95 (0.46–1.98)	1.34 (0.73–2.46)	1.20 (0.76–1.91)
Obese	1.05 (0.43–2.54)	1.22 (0.63–2.37)	1.18 (0.70–2.00)
Cognitive functioning/mental health			
Orientation (0 bad–4 good)			
Good	1.00	1.00	1.00
1–3	1.39 (0.70–2.75)	1.26 (0.75–2.10)	1.29 (0.59–2.80)
Bad	.	1.01 (0.29–3.80)	1.40 (0.61–3.24)
Numeracy score (1 bad–5 good)			
Good	1.00	1.00	1.00
2–3	1.29 (0.48–3.47)	1.28 (0.34–4.79)	1.29 (0.59–2.80)
Bad	2.18 (0.70–6.81)	1.15 (0.30–4.48)	1.40 (0.61–3.24)
EURO-D scale (0 not depressed–12 very depressed)			
Not depressed	1.00	1.00	1.00
1–2–3	1.05 (0.46–2.40)	0.69 (0.22–2.16)	0.90 (0.46–1.74)
4–12	1.59 (0.54–4.67)	0.68 (0.20–2.34)	1.04 (0.48–2.25)
Health behaviors			
Physical inactivity			
Other§	1.00	1.00	1.00
Yes	1.28 (0.56–2.92)	0.85 (0.46–1.54)	0.99 (0.61–1.61)
Ever smoked daily			
No	1.00	1.00	1.00
Yes	1.82 (0.90–3.66)	1.09 (0.32–3.70)	1.58 (0.89–2.80)
Alcohol consumption			
Other	1.00	1.00	1.00
>2 glasses of alcohol 5–6 days a week	0.99 (0.49–2.01)	0.33 (0.04–2.67)	0.87 (0.46–1.64)

†The sum of affirmative self-reports to the diagnosed conditions at baseline. ‡The number of medical symptoms present for at least the past 6 months at baseline. §Self-reports of carrying out moderate or vigorous physical activities one to three times a month, once a week, or more than once a week; adjusting for age, sex, years of education, heart attack/stroke and depression. Note: Odds ratio (OR) for functional decline in men with bad orientation is not shown because of the small number of individuals within this category. BMI, body mass index; CI, confidence interval, EURO-D, Euro-Depression scale (0 not depressed–12 very depressed); SRHS, Self Rated Health Status.

Table 4 Odds ratios for functional decline by decrease in general welfare at follow up

Variables	Functional decline OR (95% CI) Men	Women	Total
Self-reported health			
Δ SRHS (1 excellent–5 poor)			
No change/improved	1.00	1.00	1.00
Decreased	1.69 (0.90–3.14)	1.32 (0.81–2.16)	1.46 (1.00–2.19)
Δ Chronic diseases			
No change/less	1.00	1.00	1.00
Increased	2.25 (1.21–4.19)	1.33 (0.82–2.17)	1.63 (1.11–2.39)
Δ Symptoms			
No change/less	1.00	1.00	1.00
Increased	3.66 (1.94–6.88)	2.36 (1.45–3.86)	2.81 (1.91–4.12)
Δ BMI			
No change/improved	1.00	1.00	1.00
Worse	1.38 (0.59–3.24)	0.95 (0.49–1.83)	1.07 (0.63–1.79)
Cognitive functioning/mental health			
Δ Orientation (0 bad–4 good)			
No change/improved	1.00	1.00	1.00
Decreased	1.59 (0.70–3.62)	1.22 (0.65–2.27)	1.31 (0.80–2.14)
Δ Numeracy score (1 bad–5 good)			
No change/improved	1.00	1.00	1.00
Decreased	1.71 (0.89–3.25)	1.88 (1.05–3.34)	1.81 (1.19–2.78)
Δ EURO-D scale (0 not depressed–12 very depressed)			
No change/improved	1.00	1.00	1.00
Decreased	5.05 (2.42–10.54)	1.89 (1.08–3.29)	2.74 (1.78–4.22)

Adjusting for age, sex, years of education, heart attack/stroke, depression and level of disability at baseline. Δ: change across time (Δ = first wave [W1] – second wave [W2]). If welfare status decreases between W1 and W2 =1, no change/improvement =0 (reference category). Worse body mass index (BMI) was established when individuals change their BMI category in W1 to a worse BMI category in W2 – normal to underweight or normal to overweight or normal to obese or overweight to obese. CI, confidence interval; EURO-D, Depression scale (0 not depressed–12 very depressed); SRHS, Self Rated Health Status.

An age-dependent FD is observed. Older individuals show higher OR for FD across waves, especially in men. The analyses for the whole sample show an educational gradient in FD, although not significant. Regarding self-reported health, individuals with fair and poor SRHS have a higher risk of FD than those with excellent or very good SRHS, even after adjusting by confounders. The number of symptoms seems to be associated with increased disability as well. Adjusting for confounders attenuated the associations of cognitive functioning/mental health and health behaviors with FD.

There were sex differences in the association of baseline covariates and disability. Compared with women, older and poorly educated (low/primary) men were more likely to show FD across waves. Instead, their SRHS and self-reported BMI were not associated with disability. Among women, a lower SRHS was significantly associated with FD.

Table 4 shows the decrease in general welfare in the covariates at follow-up, adjusting for confounders. An increased number of chronic diseases and symptoms between W1 and W2, and decreased SRHS together with worse numeracy and EURO-D score were significantly associated with FD in the whole sample. FD in men was more strongly associated with an increased number of chronic diseases and increased depressive symptoms, whereas among women the association was stronger for numeracy score.

Discussion

The purpose of the present study was to assess the baseline and longitudinal predictors of 2-year changes in physical functioning based on a composite index of functional status. At baseline, we found that age, educational level, self-rated health, number of symptoms and chronic diseases were associated with FD over a 2-year period. Longitudinally, we found that FD was correlated with a decline in self-rated health, an increase in the number of chronic diseases and symptoms, reduced numeracy score, and increased depressive symptoms. Our findings suggest that in addition to age, educational level, self-rated health, the onset of symptoms, the onset of chronic diseases and depressive symptoms, and reduced numeracy score are clinical predictors potentially useful in the prevention of functional disability.

In general, baseline levels of self-reported health were more strongly associated with FD among women. This finding is in line with previous evidence of worse self-reported health among Spanish women when compared with men.[24] Similarly, our findings differ from those reported for the USA population[23] as well, where poor global self-reported health affected functional decline in men only. Variations in the study population, framing of the question and response formats, variables controlled for, follow-up periods, and cultural differences might all partially account for the differences in results.[23] We found no association between baseline physical inactivity and the occurrence of decline in function after 2 years. This is quite surprising, as several studies have observed individuals' functional fitness level to be associated with functional decline.[3,25] It is probable that our indicator of physical inactivity might not sufficiently capture health changes that occur during the rather short time-span studied in the present analysis.

Although men reported better health than females, changes in self-reported health were more strongly associated with decline in men. One possible interpretation is that health and symptoms are already so much worse for women than for men at baseline, that longitudinal changes for women are smaller than for men, due to ceiling effects. As a result, at any given age, change can appear to be a stronger predictor for the relatively healthier men, whereas the already poor levels of health at baseline might turn out to be stronger predictors for women. Our findings also suggest that change is a stronger predictor of FD than baseline levels. A possible explanation is that all these changes occur simultaneously; that is, as people develop a new chronic disease they are also more likely to be impaired, whereas baseline levels reflect more the result of health experiences over the life-course rather than a recent change in health.

Previous longitudinal studies have shown a higher prevalence of disability among low educated participants.[11,12] The present results are generally consistent with these studies. Compared with men with medium/high education, low educated men were twice more likely to experience FD after 2 years. However, no formal education in women seems to be protective against FD. This might sound surprising, but similar findings for other physical health outcomes have been previously observed.[26,27] These results might be explained by a cohort effect, as the few Spanish women with university education at middle-age have had a greater lifetime exposure to stressful life events than women with a lower level of education.[27] The effort required to compete in an occupational sector dominated by men, in addition to responsibility for household domestic chores at a time when family responsibilities were assumed exclusively by women, could explain this greater exposure to risk factors of a psychosocial nature.[27]

Longitudinally, we found that changes in cognitive functioning and mental health were more strongly associated with FD than factors at baseline. These results are in line with a study carried out in Spain,[6] where the presence of cognitive problems and depressive symptoms predicted transitions in functional status. Furthermore, a distinctive result was found in the present study related to changes in depressive symptoms; men with decreased EURO-D score across waves had five times the odds of FD as compared with men who did not experience a change in the EURO-D score; whereas for women, the effect was smaller. This finding could be explained by previous results from a cross-national comparison of depressive symptoms.[28] The prevalence of depressive symptoms is higher in women than in men in most European countries, probably because of a higher exposure to gender-based sociostructural risk factors, poorer health and higher disability along their life course. However, despite the higher exposure to these risk factors, women might not be more vulnerable to them.[28] Findings in the aforementioned study show that the female excess in depressive symptoms remains after taking into account the higher prevalence of sociostructural and health-related risk factors, suggesting the existence of additional pathways linked to gender and/or biological sex.

The use of dynamic indicators across time in the present study supports their usefulness in evaluating decline in functional status, especially among cognitive and mental health indicators. We found that increased diseases and symptoms, together with worse numeracy and EURO-D scores across time, are more strongly associated with FD than baseline levels. This suggests that identifying changes in clinical practice might potentially be more useful than examining levels only if the aim is to predict future FD.

The prevention/delay of the onset of disability in older adults, particularly among older women, could have a positive impact on their quality of life.[8] Effective strategies are required for the prevention or rehabilitation from FD, which could help reduce the incidence of disabilities and the period of dependence near the end of life.[2] The present study provides tools for the clinical prediction of FD, which might help curb increasing trends in disability in the older Spanish population.

Several limitations in this study need to be highlighted. First, we cannot entirely treat the factors considered as causal, as they might simply occur together with changes in functional disability. For example, it is likely that the correlations between the number of chronic diseases and FD reflect either a causal effect from chronic disease to physical function, the impact of physical function on the onset of diseases or a common biological process that causes both FD and the onset of symptoms, without the latter being causally related. However, the present study did not aim to establish the causal association between these factors and FD, but to identify useful clinical predictors for the prevention of FD. Thus, results referring causality of the potential loss of functional capacity must be interpreted with caution. Another limitation was a possible flooring effect for those elderly with already severe disability at baseline ($n = 34$), who cannot experience further FD during the follow-up period.

An additional limitation of the present study was the use of self-reported weight and height to estimate BMI.[29] This might result in an underestimation of BMI, as Spanish people over-report height compared with other Europeans.[30] We found no significant association between self-reported BMI with FD. Future studies based on measured height and weight are required to confirm this finding.

In conclusion, we assessed the baseline and longitudinal predictors of 2-year FD, where the latter were strongly associated with FD, most clearly among men. We found that FD is correlated with baseline age, education, self-rated health, number of symptoms and chronic diseases, as well as with declining self-rated health, increasing number of chronic diseases and symptoms, reduced numeracy score, and increasing depressive symptoms. These variables are potentially useful clinical predictors for the prevention of functional disability among the elderly.

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Disclosure statement

The authors declare no conflict of interest.

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